COMBAT RATION NETWORK FOR TECHNOLOGY IMPLEMENTATION

Polymeric Tray Manufacturability, Part II

Final Technical Report STP1002B
Results and Accomplishments (January through July 1998)
Report No: FTR 102
CDRL Sequence: A004
February 1999

CORANET CONTRACT NO. SPO103-96-D-0016

Sponsored by:
DEFENSE LOGISTICS AGENCY
8725 John J. Kingman Road
Ft. Belvoir, VA 22060-6221

Contractor:
Rutgers, The State University of New Jersey
THE CENTER FOR ADVANCED FOOD TECHNOLOGY[2]
Cook College
N.J. Agricultural Experiment Station
New Brunswick, New Jersey 08903

Principal Investigator:
Henderikus B. Bruins

Dr. John F. Coburn
Program Director

Tel: 732-445-6130
Fax: 732-445-6145

[2] A New Jersey Commission on Science and Technology Center

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
February 1999

3. REPORT TYPE AND DATES COVERED
Final January through July 1998

4. TITLE AND SUBTITLE
Polymeric Tray Manufacturability, Part II
(Short Term Project - STP1002B)

5. FUNDING NUMBERS
SP0103-96-D-0016
PE-7811s
PR-~~88003~~
96004

6. AUTHOR(S)
Henderikus B. Bruins

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Rutgers, The State University of New Jersey
The Center for Advanced Food Technology
Cook College, NJ Agricultural Experiment Station
New Brunswick, NJ 08903

8. PERFORMING ORGANIZATION REPORT NUMBER
FTR 102

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Logistics Agency
8725 John J. Kingman Road
Ft. Belvoir, VA 22060-6221

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Part I of the Polymeric Tray Manufacturability was conducted January 19-23, 1998 at Star Foods Processing Inc, San Antonio, TX. Initial analysis indicated problems with lid sealing and head space control serious enough to probably fail the U.S. Army Natick Research, Development & Engineering Center testing cycle on one or more of the four test products. Therefore, a second Polymeric Tray Manufacturability at the CORANET Demonstration Site at Rutgers University Food Manufacturing Technology Facility was conducted on June 9-10, 1998 to specifically address these issues. This report documents the manufacturability of two products, Chicken Chow Mein and Pork Sausage, which were produced during this second test. Both products were submitted to the U.S. Army Natick Research, Development & Engineering Center for package integrity testing. This study demonstrated that residual gas levels can be controlled within specification limits and that with proper retort racking design in combination with overriding pressure control, the container can be protected from deformation. However, it was also demonstrated it was difficult to control the seal width within the specifications limits on the Raque Heat Sealer at the FMT facility, warranting additional work in this area.

14. SUBJECT TERMS

15. NUMBER OF PAGES
62

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. SECURITY CLASSIFICATION OF ABSTRACT
Unclassified

20. LIMITATION OF ABSTRACT
UL

Summary

The CORANET Manufacturing Study conducted on June 9-10, 1998 at the CORANET Demonstration Facility had the following objectives:

- Upgrade the Raque Heat Sealer to accommodate the Military Polymeric Tray
- Design and acquire retort racks specifically for the Polymeric Tray and in sufficient quantities to support the Manufacturability Test
- Define the selected product/processes in order to produce acceptable final product for military use
- Conduct a full production run on two selected military tray pack products including quality control inspection and a manufacturability audit

Of the 21 Process Capability Indexes (PCI) computed, 12 were better than 1.2. Residual gas yielded a minimum PCI of 0.61 and 2.21 for Pork Sausage and Chicken Chow Mein respectively. Seal Defects yielded a negative PCI: -0.06 and -0.32, respectively, mainly due to the seal blistering problems. Seal Integrity yielded, however, an undetermined high PCI as no defects were identified in the samples tested.

The manufacturability study demonstrated that the maximum residual gas level of 175 cc can be achieved if vacuum pressures in excess of 20 inches Hg are used. These high vacuum pressure do cause, however, some concern with hot fill products as flashing could occur. Product fill temperatures were therefore kept below 160 F.

The manufacturability study demonstrated a problem with the "operational window" in which the sealer has to be operated. Normal sealing conditions yielded an inconsistent and below specification seal width. Variation in tray flange thickness required higher seal pressures and long seal times. However, the longer seal times caused delamination defects in the lid stock seal area due to a weak bond of the outer laminate. To be successful in producing these trays, the operational window has to be widened, both by reducing the flange thickness variations, by using lid stock which can withstand higher seal temperatures and by modifying the sealer carriers such that they can compensate more for the flange thickness variations.

The yield of the Ham Slice product was low for the first lot but dramatically improved for the second run when sealing conditions were adjusted. The yield of the Chicken Chow Mein product was low for both lots due to the blistering of the lid stock. However, the seal strength of the trays, even of those who were rejected by the in-process inspection process, was adequate, as determined by Natick. The blisters observed during this production did not seem to affect the seal integrity.

The overall filling and sealing rate ranged from 9.3 to 10.2 trays/min. The line speed can be increased with capital investment up stream and down stream from the packaging line to facilitate faster filling and retort crate loading, and by using trays with more consistent flange thickness to allowing shorter seal times.

Test Conditions

Test Variables

A total of two products were produced at the Rutgers FMT Facility during the week of June 9, 1998. The two products were:

- Chicken Chow Mein, Thermostabilized NSN:8940-01-446-0214
- Pork Sausage Links in Brine, Thermostabilized NSN: 8905-01-446-0215

Each product was produced in two type trays. The Type II tray is the same as the type I tray, with the exception of an additional oxygen barrier. Therefore, the following finished product lots were produced:

- Lot 8160A, Pork Sausage Links in Brine, Type I/155 tray
- Lot 8160B, Pork Sausage Links in Brine, Type II/155 tray
- Lot 8161A, Chicken Chow Mein, Type I/155 tray
- Lot 8161B, Chicken Chow Mein, Type II/155 tray

Product Specification

The following specifications were in effect at the time of this manufacturability study:

- Chicken Chow Mein, Thermostabilized PCR-C-0010 - June Production Test
- Pork Sausage Links in Brine PCR-P-0003 - June Production Test
- Packaging Specification: MIL-PRF-32004 (23 May 1997) and MIL-PRF-32004 Supplement (12 December 1997)

Product Formulation

Pork Sausage was purchased from Armor Swift who normally supplies this item to ration producers. The brine solution contained 2.40% salt.

Chicken Chow Mein was formulated according to the suggested MIL-C-44467 formulation.

Water	30.86%
Chicken	28.00%
Celery	14.13%
Bean Sprouts	7.00%
Mushroom	6.00%
Water Chestnut	6.00%
Chicken Fat	2.40%
Modified Food Starch, Pur-Gel B980	2.25%
Soy Sauce	1.50%
Salt	0.85%
Onion Dehydrated	0.50%
Sugar	0.44%
White Pepper	0.07%

Process Description

The CORANET Demonstration Facility at the CAFT/FMT facility was used for the manufacturability study. The process consisted out of a scrape surface kettle to cook the product, a Raque filler to fill the Chicken Chow Mein and Oden filler for the Brine in Pork Sausage, a Raque Heat Sealer and a Stock 1100 retort. A copy of the process flow sheet is attached in the appendix.

Raque Process Conditions

Batch Code		8160A	8160B	3603	3604	3605	3606
Check Weigher LL	Oz	50.1	50.1	91	91	91	91
Check Weigher UL	Oz	52.1	52.1	95	95	95	95
Check Weigher Tare Weight	Oz	5.47	5.47	5.47	5.47	5.47	5.47
Oden Pump #1 Speed/Volume	-/-	29/2816	29/2816				
Oden Pump #2 Speed/Volume	-/-	29/2815	29/2815				
Raque Filler Setting	Mm			167	167	167	167
Sealer Temp	F	412	412	412	412	412	412
Sealer Pressure	Psig	75	75	75	75	75	75
Sealing Time	Sec	1.0	1.4	1.6	1.6	1.6	1.6
Vacuum Pressure	"Hg	20	20	20	20	20	20
Vacuum Time	Sec	3.0	3.0	3.0	3.0	3.0	3.0
Filler Line Speed	Min^{-1}	11	11	11	11	11	11
Video Jet Code	-	8160A	8160B	8161A	8161A/B	8161B	8161B

Retort Conditions

Product Code		8160A	8160B	8161A&B	8161B
Retort Cook ID	-	R02A	R02B	R02A	R02B
Initial Temperature	F	55	56	104	88
Come Up Time	Min	12	12	12	12
Retort Temperature	F	252	252	252	252
Hold Time	Min	36	36	100	106
Total Cycle Time	Min	100	100	188	195

Finished Product Quantities

From these lots the following product quantities were send to Natick for further evaluation, each case contained 4 containers. FMT nonconforming samples were trays that were rejected during the post retort inspection process. USDA nonconforming samples were trays that were rejected by the USDA when they performed the finished product inspection. USDA conforming samples passed both the post retort inspection as well as the USDA finished product inspection.

Lot 8160A: Pork Sausage in Brine, Type I Tray
- USDA conforming: 4 cases
- USDA nonconforming: 8 cases
- FMT nonconforming: 8 cases

Lot 8160B: Pork Sausage in Brine, Type II Tray
- USDA conforming: 25 cases
- USDA nonconforming: 2 cases
- FMT nonconforming: 0 cases

Lot 8161A: Chicken Chow Mein, Type I Tray
- USDA conforming: 9 cases
- USDA nonconforming: 10 cases
- FMT nonconforming: 8 cases

Lot 8161B: Chicken Chow Mein, Type II Tray
- USDA conforming: 5 cases
- USDA nonconforming: 6 cases
- FMT nonconforming: 20 cases

Results

During the production observations were made by the CORANET Manufacturability Team. These comments can be divided into three categories:

1. General Comments and Observations around the Filling and Sealing Line
2. Traditional Process Performance Measurements such as Yield and Line Efficiencies
3. Process Capability Measurements to produce product within specification limits

General Comments and Observations

Sealing Time

Open and narrow seals were produced during the first lot of Sausage in Brine which was attributed to colder than normal trays (trays were stored in refrigerator). The sealing time was then increased to 1.4 seconds for the second lot (8160B) with the improved result of no open seals and only several narrow seals. For the following day production of Chicken Chow Mein the seal time was increased further to 1.6 seconds. This had the effect of widening the seals well in excess of the specification minimum 1/8", however produced blistering of the lidding material. Although these seal defects were scored by inspectors as product inclusions or narrow seals, most if not all were actually blisters. Upon examination of the blisters, the defect was found to be very small areas of delamination of the outer polyester laminate and foil.

Polymeric Tray

The polymeric tray was produced by Rexam and was obtained from Natick's inventory. The type II trays contained an additional oxygen absorbent additive to increase the shelf life of the tray. Type I and Type II performed identically throughout the manufacturing process. Type II trays are over wrapped in a foil bag which must be discarded just prior to filling. Flange thickness variation was .060-.079" which meets the Rexam product specification of .020" maximum variation. It was observed that narrow seals occur consistently near the thinnest corner of the seal flange. When looking into the tray with the mold number at 6 o'clock position, the thinnest area is located at the corner at the 2 o'clock position for trays thermoformed in lane 1 (mold numbers 1xx) and at the 4 o'clock position for trays thermoformed in lane 2 (mold numbers 2xx). The seal pressure of 75 psi was needed to minimize seal width variation (typical seal pressure is 40 psi). This problem might be reduced with tighter tolerance on flange thickness.

Top Film

Lid stock was fresh MRE roll stock material from Jefferson-Smurfit. The film performed well throughout the manufacturing process with the exception of the seal width/blister problem already noted. The problem may be solved by testing/optimizing sealing conditions, which due to time constraints of this project were not complete. Despite seal width/blister problems, seal strengths as measured by burst test were found to be adequate.

Heat Sealer

Raque Heat Seal machine functioned well during the demonstration. The machine operated in the automatic mode which adjusts speed to that of the filling system (approximately 9-11 trays per minute). The Heat Sealer is capable of sealing up to 30 trays per minute, but was constraint to about 14 trays per minute by the vacuum / seal machine parameters. On one occasion the machine aborted the seal cycle for no apparent reason and 4 unsealed trays were discharged. The vacuum system was not operating near the end of the Chicken Chow Mein production run to observe the effects of vacuum on the quality of the seal, which resulted in 3 cycles (12 trays) with excessive residual gas (trays rejected).

Tray carriers, which transport trays through the Sealer, were replaced for this manufacturability demonstration in order to fit the Rexam tray. These carriers were designed to accommodate both Rexam (polypropylene) and Mullinix (CPET). Concerns about the round gasket producing narrow seals were raised. Gasket width is being looked into by Raque Food Systems.

A vacuum of approximately 20"Hg was required to evacuate the headspace below 175cc. Seal contamination from product flash (water rapidly vaporizing) is a concern for hot filled product but was not observed during this production. Also the lower chamber vents more slowly than the upper chamber causing a pressure imbalance across the tray. It is not known whether this stresses the tray but does cause additional wear on the Sealer as observed by the loud sound that occurs when the upper/lower chamber separate. The Sealer does not have transducers to monitor proper vacuum level within each seal chamber, an upgrade that is recommended for production machines.

Retort

Retort racks were specifically developed to support the processing of military polymeric trays in a full water - still retort. Based on the previous conducted manufacturability study, it was learned that the rack can leave permanent impressions on the lid stock and cause problems for the label to adhere to the lid stock. It was also learned that the weight of the container when not properly supported by the rack system can cause compression defects on the trays below. A rack configuration was therefore developed that had four pockets in each layer, one for each tray, with a pocket height of 1.8 inches. A total of ten layers fitted in each retort crate and a full retort load consisted of four retort crates. The lid stock was exposed to a Teflon spacer mat that would prevent deep impressions in the lid stock. The tray body was exposed to an MRE rack which facilitated the water flow around the tray. Based on industry standards, the trays were loaded with the lid stock down which might have advantages in product appearance, but make it more difficult to load and unload the tray.

Damage to the container can also occur when in-appropriate pressures are used during the retort cycle. The minimum pressure profile of the retort process was determined through the use of a "Pressure Profiler". Actual process pressures were set slightly higher to avoid any expansion of the polymeric tray during the process.

Residual Gas and Product Fill Temperature

The residual gas level in the tray is a function of the head space, the product temperature and the vacuum applied during sealing. Even though the maximum residual gas is specified at 175 cc, the actual target residual gas needs to be well below this and is a function of expected variation in residual gas level. The maximum vacuum level that can be pulled is a function of the product temperature as product flashing should be avoided at all times. This causes some concern with typically hot filled products such as Chicken Chow Mein. To avoid potential problems and meet the residual gas level specification, we cooled this product down to below 160 F by adding the precooked diced chicken at refrigerated temperature and limit the reheat time.

Internal Pressure Tester

The design of the internal pressure apparatus is critical to the performance of the tray during this test and needs to be clearly specified. The tests at the FMT Facility were performed in a tester which did not confine the tray. This caused the tray to bulge out and perform a tensile test on the film rather than a seal integrity test. Most trays failed in this test environment due to film fracture. The USDA tested trays at STAR Foods, using their tester which confines the tray. All trays passed in this testing apparatus

Drain Weight Test

The drain weight test methodology for Chicken Chow Mein was changed compared to previous specifications. It is required that a total drain weight is determined for both the chicken and vegetables. This test methodology is extremely time consuming (1-2 hrs per sample). The USDA recommended an alternative approach in which a total drain weight spec is set plus a drain weight spec for discernable dices of chicken. We support their recommendation.

Traditional Process Performance Measurements

Production Efficiency:

The production line speed can be reported as three numbers. The first number is the actual line speed set-point of the filling and sealing line. The second number is the average line speed of the filling and sealing operation, not counting major breakdowns or line stoppages. The third number is the average production rate of accepted trays send to the retort, not counting major breakdowns or line stoppages. All data is reported in Trays/Min.

	Line Speed	Filling/Sealing	Production Rate
Sausage in Brine	11 trays/min	9.3 trays/min	7.9 trays/min
Chicken Chow Mein	11 trays/min	10.2 trays/min	5.6 trays/min

Production Yield:

At several locations the product and container were inspected. The first location of inspection was during check weighing operation where the check weigher removes any trays which were under or over weight. Next all trays were inspected before they were loaded on to retort crates: "Pre-Retort Inspection". The last point of inspection was after the retort process but before product casing: "Post Retort Inspection". If a container is found to be potentially defective then the container was removed from the production line. Product in containers removed before the retort process can be recycled, and only resulted in the economic loss of the container. Containers removed from the production line after the retort process are either destroyed, used for commercial sale or used for Quality Control testing. The table below reports on the yield [%] at the various inspection points.

	Sausage in Brine	**Chicken Chow Mein**
Trays Filled	347	419
Rejected during Filling	35	0
Trays Sealed	312	419
Yield Filling	89.91%	100.00%
QC Samples	9	5
Trays Inspected Pre-Retort	303	414
Defectives (Pre-Retort)	47	188
Trays Retorted	256	226
Yield Pre-Retort	84.49%	54.59%
QC Samples	1	0
Trays Inspected Post-Retort	255	226
Defectives (Post-Retort)	71	83
Trays Inspected by USDA	184	143
Yield Post-Retort	72.16%	63.27%
Trays Rejected by USDA	53	74
Trays Accepted	131	69
Yield USDA	71.20%	48.25%

Process Capability Analysis

Process Capability is the capability to produce product within the specification limits. The analysis were limited to the product and tray characteristics, such as net weight, drain weight, fat and salt content, residual gas and internal pressure. Capability analysis was done separately on data from each individual data source: Rutgers/FMT, USDA and CORANET. The minimum value of each data set is reported in the summary table below. The process capability index (PCI) reported is a direct indication to the capability of the process to produce product within specification limits. The target PCI is "1.2" or better. A PCI=1 means that the process produces 99.7% of the product within specification limits. A PCI=0 means that 50% of the product is defective. A PCI<0 means that the majority of the product is defective. Additional information on the interpretation and calculation of PCI can be obtained by requesting TWP#106: "A producibility index with process capability and manufacturing cost."

During the previous manufacturability test at STAR Foods, it was concluded that there is no significant difference between the two tray configuration. The data was therefore grouped together per product and analyzed as such.

Rutgers Process Capability Summary

	Defect Type	Sausage in Brine	Chicken Chow Mein
Net Weight 1)	Minor	0.80	3.13
Drain Weight Sausage 1)	Minor	3.47	
Drain Weight Vegetables 1)	Minor		-0.51
Drain Weight Chicken 1)	Minor		-2.02
Residual Gas 1)	Major	0.61	2.21
Salt 2)	Minor	1.43	ND
Fat 2)	Minor	12.98	1.85
Protein 2)	Minor	0.48	-0.71
Internal Pressure	Major	ND	ND
Seals 3)	Critical	-0.06	-0.32
PCI Critical		-0.06	-0.32
PCI Average		ND	ND
MC 4)		4.03	1.7

ND: Could not be determined

1) PCI indexes for net weight, drain weight and residual gas are based on the minimum of FMT, USDA and CORANET (where available) PCI's.
2) PCI indexes for salt, fat and protein are based on the combined FMT and USDA data sets.
3) PCI index for seal defects is based on pre-retort, post-retort and USDA screening operations.
4) MC index (Manufacturing Cost) is based on the process capability to produce acceptable containers

Recommendations

Pork Sausage

1) Increase net weight target by adding more brine
2) Increase vacuum level during sealing to decrease average residual gas level and/or decrease variability in residual gas level by identifying cause and effect (chamber leak?)
3) Reformulate sausage formula to increase protein content and/or widen specification limits to accept current used product
4) Improve sealing operation to make process more robust and forgiving for variability of packaging material and/or determine cause and effect and reduce causes (flange thickness and top film blistering) and/or modify specification

Chicken Chow Mein

1) Reformulate to increase chicken weight and/or widen specification
2) Reformulate to increase vegetable weight and/or widen specification
3) Improve sealing operation to make process more robust and forgiving for variability of packaging material and/or determine cause and effect and reduce causes (flange thickness and top film blistering) and/or modify specification

PCI Analysis Sausage in Brine

Net weight
Specification Limits: Average 90 oz net weight (S3/Aql=6.5, double sampling) and no individual less than 88 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 89.95 and 87.95 oz.

FMT data set: avg=90.4 oz and sigma=0.35 oz, hence the minimum PCI is 2.37 as determined by the individual spec limit (87.95 oz)

USDA data set: avg=90.2 oz and a sigma=0.45 oz, hence the minimum PCI is 0.80 as determined by the average spec limit (89.95 oz)

Drain weight
Specification Limits: Average 45.0 oz net weight (S3/Aql=6.5, double sampling plan) sample and no individual less than 43.0 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 44.95 and 42.95 oz.

FMT data set: avg=54.9 oz and sigma=0 oz, hence the minimum PCI could not be determined.

USDA data set: avg=51.6 oz and a sigma=0.83 oz, hence the minimum PCI is 3.47 as determined by the individual spec limit (42.95 oz)

Manufacturability study team collected data during the filling process. Trays were weighed after they were filled with sausages and this data should be a good indication regarding the drain weight that will be measured after processing. The following statistical data shows the average and standard deviation of the gross weights of the trays with sausages excluding the brine sauce and the lids: avg=51.25 oz, sigma=0.26 oz for the first run and avg=51.50 oz, sigma=0.56 oz for the second run. Increase in weight variation during the second production run was due to excessive variation in sausage link weight, probably caused by start up variations at the sausage manufacturer. This led to the rejection of some trays by the check weigher as under and over weight trays and it also led to a minor defect sited by the USDA inspector for having sausage links not of uniform diameter or length.

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Results shall be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 175.5 cc.

FMT data set: Average=136.8 cc and sigma=21.20, hence the PCI= 0.61

USDA data set: Average=142.8 cc and sigma=11.05, hence the PCI = 0.99

Salt
Specification Limits: A composite of three filled and sealed polymeric trays should be selected and drained of all brine and analyzed. Salt content shall not be greater than 2.0%. Test results should be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 2.05 %

Combined FMT & USDA data set: Average = 1.75% and sigma=0.07%, hence PCI = 1.43

Fat
Specification Limits: A composite of three filled and sealed polymeric trays should be selected and drained of all brine and analyzed. Fat content shall not be more than 33.0 %. Test results should be reported to the nearest 0.1% hence the spec limit for process capability analysis is 33.05%

Combined FMT & USDA data set: Average = 27.6% and sigma=0.14%, hence PCI = 12.98

Protein

Specification Limits: A composite of three filled and sealed polymeric trays should be selected and drained of all brine and analyzed. Protein content shall not be less than 12.0 %. Test results should be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 11.95%

Combined FMT & USDA data set: Average = 12.05% and sigma=0.07%, hence PCI = 0.48

Seal Defects

	Pre-Retort	Post Retort	USDA
Trays Inspected	303	255	184
Seal Width	15	65	40
Open Seals	18	0	2
Seal Blister/Product Inclusions	2	4	11
Seal Wrinkle	4	2	0
Other	8[1]	0	0

[1] eight trays were removed due to sealer cycle abort

The main reason for the low yield was the fact that the seal width was less than 1/8" wide and "blistering occurred within the seal itself. The seal width problems were caused by the design of the tray flange area and the sealing chamber, which basically does not allow for wide seals. This blistering effect in the seal area is normally attributed to product contamination or inclusions. However, in this case, it might have been caused by a blistering of the film laminate.

The percentage defects of 56.62%, and its corresponding Z score of –0.17, leads to a PCI of –0.06.

PCI Analysis Chicken Chow Mein

Net weight
Specification Limits: Average 92 oz net weight (S3/Aql=6.5, double sampling) and no individual less than 90 oz net weight. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 91.95 and 89.95 oz.

FMT data set: avg. = 92.74 oz and sigma = 0.24 oz, hence the minimum PCI is 3.87 as determined by the individual spec limit (89.95 oz)

USDA data set: avg. = 92.60 oz and a sigma = 0.18, hence the minimum PCI is 3.40 as determined by the average spec limit (91.95 oz)

CORANET data set; avg. = 92.86 oz and sigma = 0.31 oz, hence the minimum PCI is 3.13 as determined by the individual spec limit (89.95 oz)

The USDA data set for the second lot of Chicken Chow Mein shows a dramatic increase (approx. 3 oz.) in the average net weight. Although some increase in weight is validated by the data collected by FMT and CORANET, its magnitude is found to be much smaller than that of the one reported by USDA. FMT and CORANET data shows an increase of approximately 0.6 oz. The exact reason for this discrepancy could not be determined at time of writing this report and is still under investigation. Therefore, the average and the standard deviation for the USDA data set are calculated based only on the data collected for the first lot of Chicken Chow Mein.

Drain Weight of Vegetables
Specification Limits: (S3/Aql=6.5, double sampling plan) No individual less than 20.8 oz net weight. The average drain weight should be not less than 22.8 oz. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 20.75 oz and 22.75 oz.

FMT data set: avg. = 25.93 oz and sigma = 1.35 oz, hence the minimum PCI is 1.28 as determined by the individual spec limit (20.75 oz)

USDA data set: avg. = 22.31 oz and a sigma = 1.15 oz, hence the minimum PCI is –0.51 as determined by the average spec limit (22.75 oz)

Drain Weight of Chicken
Specification Limits: (S3/Aql=6.5, double sampling plan) No individual less than 23.2 oz net weight. The average drain weight should be not less than 25.2 oz. Weights shall be reported to the nearest 0.1-ounce, hence the spec limit for process capability analysis is 23.15 and 25.15 oz.

FMT data set: avg. = 22.02 oz and sigma = 1.92 oz, hence the minimum PCI is –1.33 as determined by the average spec limit (25.15 oz)

USDA data set: avg. = 22.69 oz and a sigma = 1.62 oz, hence the minimum PCI is –2.02 as determined by the average spec limit (25.15 oz)

Residual Gas
Specification Limits: Residual gas maximum 175 cc. Residual gas levels shall be reported to the nearest 1 cc, hence the spec limit for process capability analysis is 175.5 cc.

FMT data set: Average=114.67 cc and sigma=5.13, hence the PCI= 3.95

USDA data set: Average=116.17 cc and sigma 8.93, hence the PCI= 2.21

Salt

Specification Limits: Sample size: 3 trays. Salt not greater than 1.3 %. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 1.35 %.

Combined FMT & USDA data set: Average = 0.9% and sigma=0 %, hence PCI could not be determined.

Fat

Specification Limits: Sample size: 3 trays. Fat not more than 5.0 %. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 5.05%

Combined FMT & USDA data set: Average = 3.5 % and sigma=0.28 %, hence PCI = 1.85

Protein

Specification Limits: Sample size: 3 trays. Protein not less than 9.0 %. Results shall be reported to the nearest 0.1%, hence the spec limit for process capability analysis is 8.95%

Combined FMT & USDA data set: Average = 7.23 % and sigma=0.81 %, hence PCI = -0.71

Seal Defects

	Pre-Retort	Post Retort	USDA
Trays Inspected	414	226	143
Seal Width	3	1	3
Open Seals	1	0	0
Seal Blister/Product Inclusions	172	80	64
Seal Wrinkle	0	2	0
Other	12[2]	0	7[3]

[2] Twelve trays were removed due to tests of "no vacuum"

[3] Seven trays were identified with abrasions/delamination type defects

The main reason for the low yield was due to "blistering" that occurred within the seal itself. Seal width problems were reduced due to longer seal times. This longer exposure to the sealing temperature probably contributed to the blistering/delamination of the film in the seal area.
The percentage defects of 83.33%, and its Z score of –0.97, leads to a PCI of –0.32.

PCI for Internal Pressure

Defect Type: Internal Pressure Test. This test requires that the container is confined between two plates and pressurized (20 psig) for 30 seconds. The seal either fails or passes during this test. A total of 12 samples from both products (four lots) were tested. It was determined that the test apparatus can greatly influence the results of this test. The USDA tested several containers initially at the FMT facility in Natick's apparatus that did not confine the tray. This apparatus lead to several failures of the film (not seal). Samples were the tested in STAR Foods apparatus with no failures. Natick has since improved on the design of their apparatus with improved results. Because no defects were found, no estimation could be made for a PCI for Internal Pressure.

General Comments Filling, Seal Contamination, Sloshing and Mounding

Sausage in Brine

- The product was filled in a two stage filling process. First the trays were filled with defrosted sausages. The sausages were positioned in three rows and two layers. Positioning of the sausages in the tray was a time consuming activity as 72 sausages need to be placed accurately to avoid mounding above the seal lid. The trays were then checked for fill weight and sausages were either added or subtracted to obtain a fill weight range. In a final check the trays were run over a check weigher to discard any under and over weights. In the next step the tray were conveyed to the Raque Heat Sealer and placed in a sealing carrier. Prior to sealing, the brine was added in a two stage filling operation, using an Oden pump with two filling nozzles.
- Trays were inspected for seal contamination at this location with an overall contamination score of 7.0 (0=clean, 125=very contaminated). This level of seal contamination could lead to seal defects. The seals were however wiped prior to sealing.
- No sloshing was observed as the line runs "continuous" rather than "indexing", and the brine was added after the tray was dropped into the sealing carrier.
- No mounding was observed as each tray was carefully filled with defrosted sausages

Chicken Chow Mein

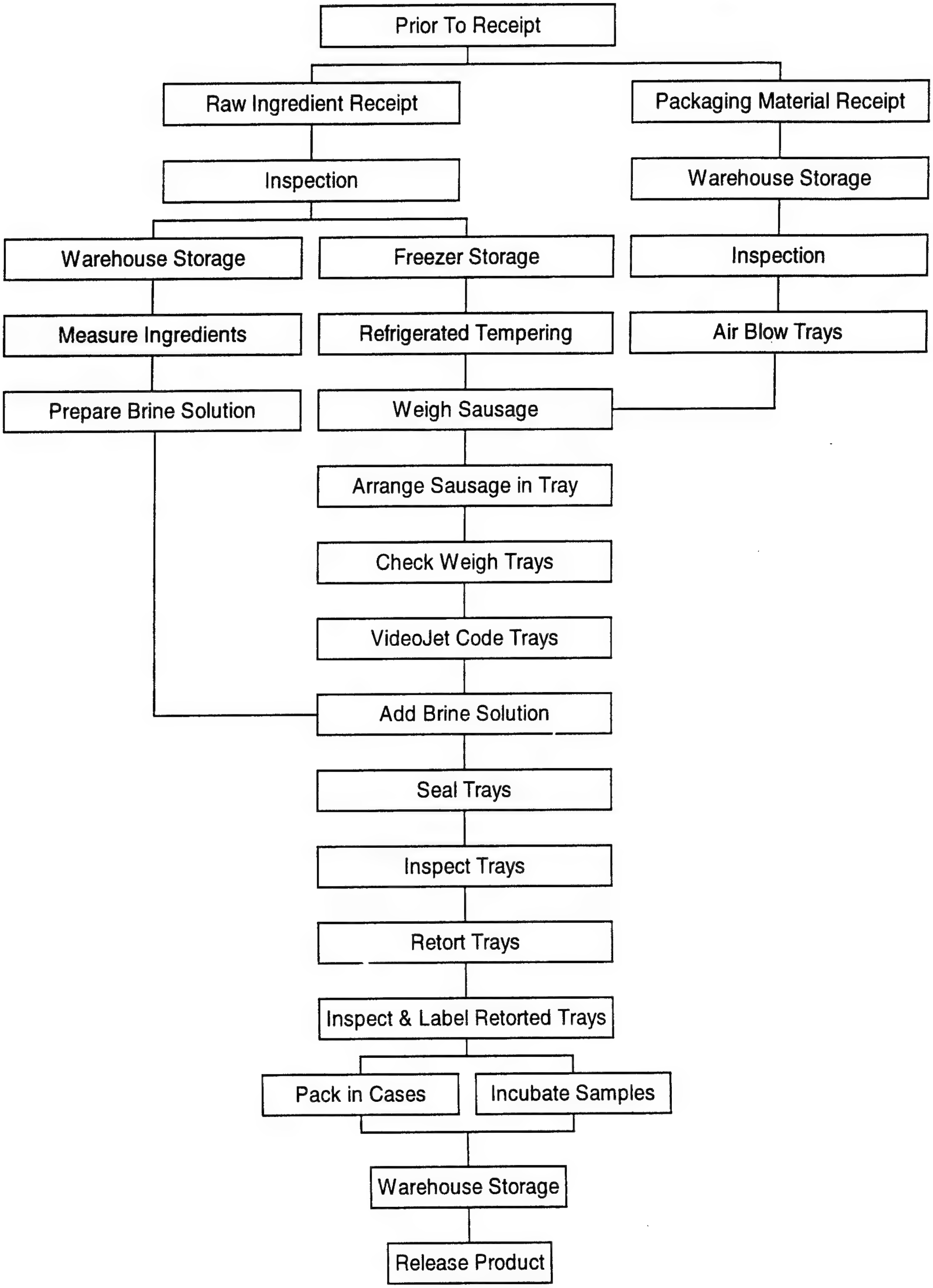
- This product was filled in a single stage filling operation using a Raque single piston filler.
- Seal contamination was monitored during this operation with a score of 16.5. This number was significant higher then experienced at STAR Foods where a score off 1.52 was achieved. The higher seal contamination could have been caused by the higher line speed and shorter time available to fill the container and/or due to differences in product consistency leading to more splashing during the filling operation. This level of seal contamination could lead to seal defects. The seals were however wiped before sealing.
- No sloshing was observed as the line runs "continuous" rather than "indexing".
- No mounding was observed as each tray moved over a vibrating conveyor to level the product

Appendix

1) Flow Sheet Pork Sausage in Brine
2) Flow Sheet Chicken Chow Mein
3) PCR-P-0003, Pork Sausage Links in Brine Specification
4) PCR-C-0010, Chicken Chow Mein Specification
5) MIL-PRF-32004, Packaging of Food in Polymeric Trays
6) MIL-PRF-32004-Supplement, Quality Assurance Provisions and Packaging Requirements for MIL-PRF-32004

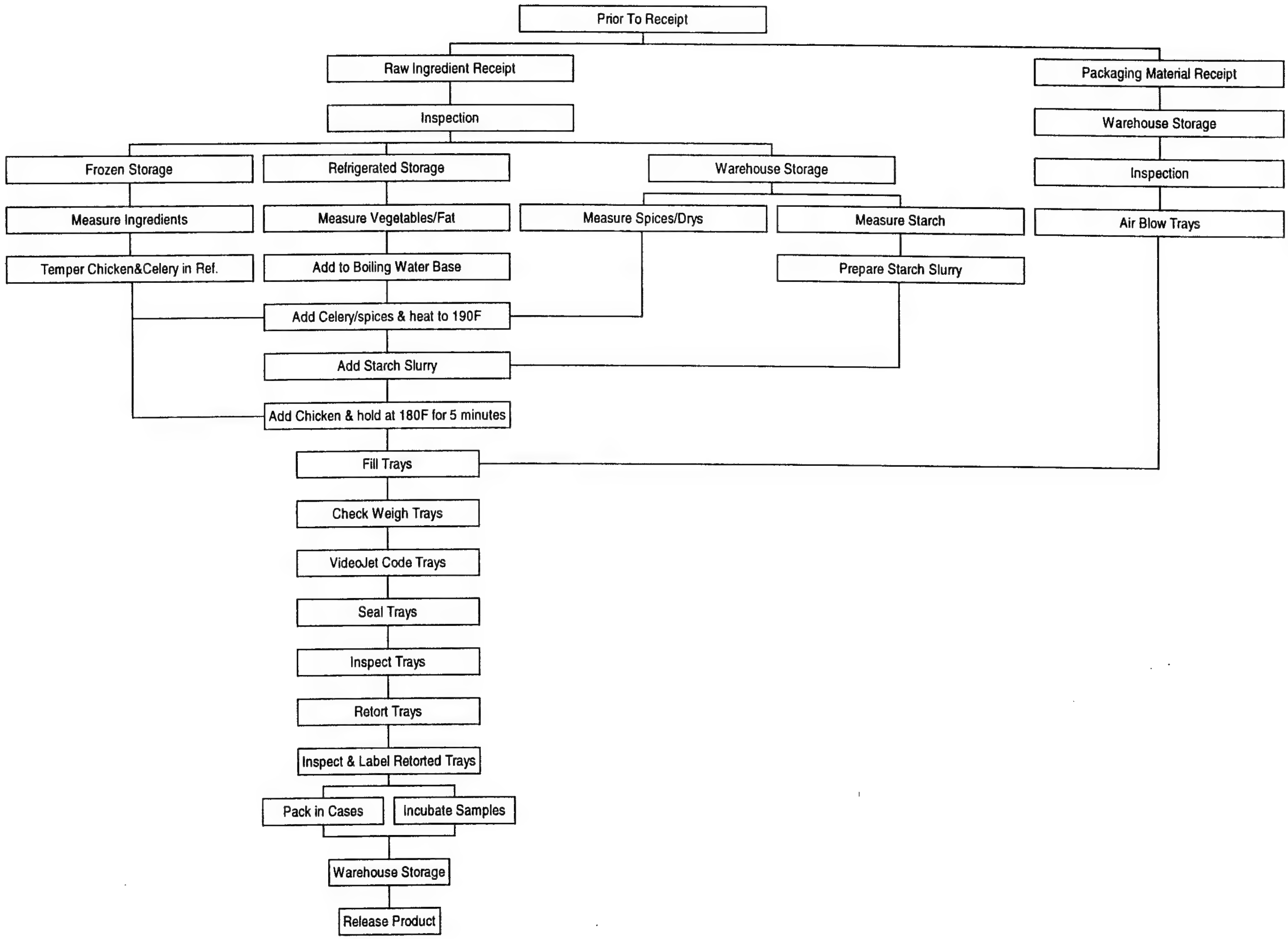
Appendix #1

P[redacted]s Flow Sheet Sausage with Brine In Tray v[redacted]



Appendix #2

Process Flow Sheet Chicken Chow Mein In Tray v4



Appendix #3

SECTION C

C-1 ITEM DESCRIPTION

PCR-P-0003 PORK SAUSAGE LINKS IN BRINE, PACKAGED IN A POLYMERIC TRAY, SHELF STABLE

Each component is consumed by combat personnel under worldwide environmental extremes as part of an operational ration, and is a source of nutritional intake. It is essential that this item be produced in accordance with good commercial practice to attain high standards of appearance, odor, flavor, and texture so that high levels of troop acceptance are achieved.

C-2 PERFORMANCE REQUIREMENTS

A. Production standard. A sample shall be subjected to first article or product demonstration model inspection as applicable in accordance with the tests and inspections of Section E of this Performance-based Contract Requirements.

B. Commercial sterility. The packaged food shall be processed until commercially sterile.

C. Shelf life. Product packaged in a type I polymeric tray (see MIL-PRF-32004) shall meet the minimum shelf life requirement of 18 months at 80°F and 60% RH. Product packaged in a type II polymeric tray (see MIL-PRF-32004) shall meet the minimum shelf life requirement of 36 months at 80°F and 60% RH.

D. Appearance.

(1) Pork sausage links. The pork sausage links shall be intact and shall be uniform in diameter and length after cooking. The links shall possess a light brown to dark brown surface color. The finished product shall be free of bone or bone fragment(s), cartilage, coarse connective tissue, section of tendons or ligaments, and glandular material.

(2) General. The packaged food shall be free from foreign material such as, but not limited to dirt, insect parts, hair, glass, wood, or metal.

SECTION C CONTINUED

E. Odor and flavor.

(1) General. The packaged food shall have a well blended, slightly spicy odor and flavor.

(2) Foreign. The packaged food shall be free from foreign odors and flavors such as, but not limited to, burnt, scorched, rancid, sour, stale, musty, or moldy.

F. Texture. The texture of the pork sausage links shall be moist and firm.

G. Weight.

2547

(1) Net weight. The average net weight shall be not less than 90.0 ounces. No individual polymeric tray shall contain less than 88.0 ounces.

2492.4

(2) Drained weight. The average drained weight shall be not less than 45.0 ounces. The drained weight of 72 intact sausage links in an individual polymeric tray shall be not less than 43.0 ounces.

H. Palatability. The finished product shall be equal to or better than the approved first article when applicable, or other approved model, in palatability and overall appearance.

I. Nutrient content. The following requirements are for drained pork sausage links:

(1) Protein content. The protein content shall be not less than 12.0 percent.

(2) Fat content. The fat content shall be not greater than 33.0 percent.

(3) Salt content. The salt content shall be not greater than 2.0 percent.

SECTION C CONTINUED

C-3 MISCELLANEOUS INFORMATION

THE FOLLOWING IS PROVIDED FOR INFORMATION ONLY TO PROVIDE THE BENEFIT OF PAST GOVERNMENT EXPERIENCE. THIS IS NOT A MANDATORY CONTRACT REQUIREMENT.

A. Pork sausage links ingredients/formulation. Ingredients and formulation percentages for pork sausage links may be as follows:

Ingredient	Percent by weight
Pork, ground	93.43
Water or ice	2.80
Salt	1.64
Dextrose	0.82
Sugar, white, granulated	0.82
Pepper, white, ground	0.23
Sage, ground	0.18
Pepper, black, ground	0.06
Ginger, ground	0.02

SECTION D

D-1 PACKAGING

Product shall be filled into polymeric trays conforming to MIL-PRF-32004 Packaging of Food in Polymeric Trays.

D-2 LABELING

Each polymeric tray shall be labeled in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

The tray lid for this product shall show the following statements:

TO HEAT IN WATER: Submerge unopened tray in boiling water. Simmer gently 35 - 40 minutes. Avoid overheating (tray shows evidence of bulging).

WARNING: Do not heat tray in oven.

TO TRANSPORT AFTER HEATING: Insert tray back into protective sleeve to protect during transport. If sleeve is unavailable, stack trays lid-to-lid with fiberboard pads in between.

CAUTION: Use care when opening as pressure may have been generated within the tray.

TO OPEN: Using a clean knife, cut the lidding around the inside perimeter of the tray seals.

SUGGESTION: Cut lid along 3 sides and fold over uncut portion. Fold back to keep unused portions protected.

YIELD: Serves 18 portions of 4 sausages each.

D-3 PACKING

Packing for shipment to ration assembler shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

SECTION D CONTINUED

D-4 UNIT LOADS

Unit loads shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

D-5 MARKING

Marking of shipping containers and unit loads shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

SECTION E INSPECTION AND ACCEPTANCE

Inspection for packaging, labeling, packing, unit loads, and marking shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

E-5 QUALITY ASSURANCE PROVISIONS

Definitions.

(1) Critical defect. A critical defect is a defect that judgment and experience indicate would result in hazardous or unsafe conditions for individuals using, maintaining, or depending on the item; or a defect that judgment and experience indicate is likely to prevent the performance of the major end item, i.e., the consumption of the ration.

(2) Major defect. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

(3) Minor defect. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.

Quality Assurance Provisions.

The following quality assurance criteria, utilizing ANSI/ASQC Z1.4-1993, Sampling Procedures and Tables for Inspection by Attributes, are required.

A. Classification of inspections. The inspection requirements specified herein are classified as follows:

(1) Production standard inspection. The first article or product demonstration model shall be inspected in accordance with the provisions of this Performance-based Contract Requirements and evaluated for overall appearance and palatability. Any failure to conform to the performance requirements or any appearance or palatability failure shall be cause for rejection.

SECTION E CONTINUED

(2) Conformance inspection. Conformance inspection shall include the product examination and the methods of inspection cited in this section.

B. Product examination. The finished product shall be examined for compliance with the performance requirements specified in Section C of this Performance-based Contract Requirements utilizing the double sampling plans indicated in ANSI/ASQC Z1.4 - 1993. The lot size shall be expressed in polymeric trays. The sample unit shall be the contents of one polymeric tray. The inspection level shall be S-3 and the AQL, expressed in terms of defects per hundred units, shall be 1.5 for major defects and 6.5 for minor defects. Defects and defect classifications are listed in Table I.

TABLE I. Product defects 1/ 2/ 3/

Category Major	Category Minor	Defect
		Appearance
101		Bone or bone fragment(s) measuring more than 0.3 inch in any dimension
102		Sausage links not intact
103		Surface color not light to dark brown
	201	Total weight of cartilage, coarse connective tissue, section of tendons or ligaments, and glandular material is more than 1.0 ounce
	202	Sausage links not of uniform diameter or length
		Odor and flavor
104		Odor or flavor not well blended and slightly spicy
		Texture
	203	Sausage links not moist or not firm

SECTION E CONTINUED

TABLE I. Product defects 1/ 2/ 3/ (cont'd)

Category Major	Category Minor	Defect
		Weight
	204	Net weight of an individual polymeric tray less than 88.0 ounces 3/
	205	Drained weight of 72 intact pork sausage links in an individual polymeric tray less than 43.0 ounces 4/

1/ Presence of any foreign material such as, but not limited to dirt, insect parts, hair, glass, wood, or metal, or foreign odors and flavors such as, but not limited to burnt, scorched, rancid, sour, stale, musty, or moldy shall be cause for rejection of the lot.

2/ Finished product not equal to or better than the approved first article, when applicable, or other approved model in palatability and overall appearance shall be cause for rejection of the lot.

3/ If the sample average net weight is less than 90.0 ounces, the lot shall be rejected.

4/ If the sample average drained weight is less than 45.0 ounces, the lot shall be rejected.

C. Methods of inspection.

(1) Commercial sterility. The sample size shall be one filled, sealed, and processed polymeric tray selected from each processed batch in the lot. Incubate the sample trays at 95°F ± 5°F for 10 days, unless otherwise specified by the inspection agency. Any evidence of swelling or microbial activity following incubation shall be cause for rejection of the lot.

(2) Shelf life. Compliance with shelf life requirement for product packaged in a type I polymeric tray (see MIL-PRF-32004)shall be determined by incubation for 18 months at 80°F and 60% RH. Compliance with shelf life

requirement for product packaged in a type II polymeric tray (see MIL-PRF-32004) shall be determined by incubation for 36 months at 80°F and 60% RH.

SECTION E CONTINUED

(3) Net weight. The net weight of the filled and sealed polymeric tray shall be determined by weighing each sample unit on a suitable scale tared with a representative empty polymeric tray and polymeric tray cover. Results shall be reported to the nearest 0.1 ounce.

(4) Drained weight test. The contents of the polymeric tray shall be poured into a U.S. Standard 1/2 inch sieve in a manner that will distribute the product evenly over the sieve. Sieve area shall be such that the distributed product does not completely cover all the openings of the sieve. The sieve shall be tilted at such an angle to assure complete drainage of liquid from the product. Drain product for two to three minutes before determining the drained weight by subtracting the sieve tare weight from the gross weight. The drained weight shall be reported to the nearest 0.1 ounce.

(5) Nutrient content. The sample to be analyzed shall be a composite of three filled and sealed polymeric trays which have been selected at random from the lot and drained of all brine. The drained samples shall be composited, prepared (see NOTE) and analyzed for protein content, fat content, and salt content in accordance with the following methods of the Official Methods of Analysis of AOAC International:

Test	Method Number
Protein	988.05
Fat	960.39, 985.15
Salt	935.47

Test results shall be reported to the nearest 0.1 percent. Any result not conforming to the nutrient content requirements shall be cause for rejection of the lot.

NOTE: The USDA will use AOAC method 983.18 for preparation of the samples.

SECTION J REFERENCE DOCUMENTS

MILITARY SPECIFICATION

MIL-PRF-32004 - Packaging of Food in Polymeric Trays

NON-GOVERNMENTAL STANDARDS

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

ANSI/ASQCZ1.4-1993 - Sampling Procedures and Tables for Inspection by Attributes

AOAC INTERNATIONAL

Official Methods of Analysis of the AOAC International

Appendix #4

SECTION C

C-1 ITEM DESCRIPTION

PCR-C-0010, CHICKEN CHOW MEIN, PACKAGED IN A POLYMERIC TRAY, SHELF STABLE

Each component is consumed by combat personnel under worldwide environmental extremes as part of an operational ration, and is a source of nutritional intake. It is essential that this item be produced in accordance with good commercial practice to attain high standards of appearance, odor, flavor, and texture so that high levels of troop acceptance are achieved.

C-2 PERFORMANCE REQUIREMENTS

A. Production standard. A sample shall be subjected to first article or product demonstration model inspection as applicable in accordance with the tests and inspections of Section E of this Performance-based Contract Requirements.

B. Commercial sterility. The packaged food shall be processed until commercially sterile.

C. Shelf life. Product packaged in a type I polymeric tray (see MIL-PRF-32004) shall meet the minimum shelf life requirement of 18 months at 80°F and 60% RH. Product packaged in a type II polymeric tray (see MIL-PRF-32004) shall meet the minimum shelf life requirement of 36 months at 80°F and 60% RH.

D. Appearance.

(1) Chicken. The chicken shall be piece sizes typically produced by a 3/4 inch dicer setting and the chicken used shall be from natural proportions. The cooked chicken shall be free of skin, bone or bone fragment(s), cartilage, coarse connective tissue, tendons or ligaments, and discolored meat. The chicken pieces shall have a characteristic cooked, chicken color.

(2) Vegetables. The vegetables shall consist of the following kinds: sliced celery, sliced water chestnuts, bean sprouts, mushroom pieces and stems, and chopped onions. The vegetables shall be discernible pieces and shall have a characteristic color.

SECTION C CONTINUED

(3) Sauce. The sauce shall have a translucent brown color and may contain visible flecks of herbs and spices.

(4) General. The finished product shall be a uniform mixture of chicken pieces and vegetables in a chow mein style sauce. The packaged food shall be free from foreign material such as, but not limited to dirt, insect parts, hair, glass, wood, or metal.

E. Odor and flavor.

(1) General. The chicken pieces shall have a mild poultry odor and flavor. The sauce shall have a pleasing chow mein style flavor.

(2) Foreign. The packaged food shall be free from foreign odors and flavors such as, but not limited to, burnt, scorched, rancid, sour, stale, musty or moldy.

F. Texture.

(1) Chicken. The chicken pieces shall be moist and tender.

(2) Vegetables. The vegetables shall be slightly soft to slightly firm.

(3) Sauce. The sauce shall be smooth and moderately thick.

G. Weight.

(1) Net weight. The average net weight shall be not less than 92.0 ounces. No individual polymeric tray shall contain less than 90.0 ounces.

(2) Drained weight.

a. Chicken. The average drained weight of chicken pieces shall be not less than 25.2 ounces. The drained weight of chicken pieces in an individual tray shall be not less than 23.2 ounces.

b. Vegetables. The average drained weight of vegetables shall be not less than 22.8 ounces. The drained weight of vegetables (combined) in an individual tray shall be not less than 20.8 ounces.

SECTION C CONTINUED

H. Palatability. The finished product shall be equal to or better than the approved first article when applicable, or other approved model, in palatability and overall appearance.

I. Nutrient content.

(1) Protein content. The protein content shall be not less than 9.0 percent.

(2) Fat content. The fat content shall be not greater than 5.0 percent.

(3) Salt content. The salt content shall be not greater than 1.3 percent.

C-3 MISCELLANEOUS INFORMATION

THE FOLLOWING IS PROVIDED FOR INFORMATION ONLY TO PROVIDE THE BENEFIT OF PAST GOVERNMENT EXPERIENCE. THIS IS NOT A MANDATORY CONTRACT REQUIREMENT.

A. Chow mein ingredients/formulation. Ingredients and formulation percentages for the chow mein may be as follows:

Ingredients	Percent by weight
Water	31.21
Chicken, cooked, diced	28.00
Celery, fresh, blanched	14.13
Bean sprouts, drained	7.00
Mushrooms, drained	6.00
Water chestnuts, drained	6.00
Chicken fat	2.40
Starch, food, modified, high opacity	2.25
Soy sauce	1.50
Salt	0.50
Onions, chopped, dehydrated	0.50
Sugar, white, granulated	0.44
Pepper, white, ground	0.07

SECTION D

D-1 PACKAGING

Product shall be filled into polymeric trays conforming to MIL-PRF-32004, Packaging of Food in Polymeric Trays.

D-2 LABELING

Each polymeric tray shall be labeled in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

The tray lid for this product shall show the following statements:

* TO HEAT IN WATER: Submerge unopened tray in boiling water. Simmer gently 35 - 40 minutes. Avoid overheating (tray shows evidence of bulging).

* WARNING: Do not heat tray in oven.

* TO TRANSPORT AFTER HEATING: Insert tray back into protective sleeve to protect during transport. If sleeve is unavailable, stack trays lid-to-lid with fiberboard pads in between.

* CAUTION: Use care when opening as pressure may have been generated within the tray.

* TO OPEN: Using a clean knife, cut the lidding around the inside perimeter of the tray seals.

* SUGGESTION: Cut lid along 3 sides and fold over uncut portion. Fold back to keep unused portions protected.

* YIELD: Serves 18 portions of 2/3 cup each.

D-3 PACKING

Packing for shipment to ration assembler shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

SECTION D CONTINUED

D-4 UNIT LOADS

Unit loads shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

D-5 MARKING

Marking of shipping containers and unit loads shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

SECTION E INSPECTION AND ACCEPTANCE

Inspection for packaging, labeling, packing, unit loads, and marking shall be in accordance with the Quality Assurance Provisions and Packaging Requirements For MIL-PRF-32004.

E-5 QUALITY ASSURANCE PROVISIONS

Definitions.

(1) Critical defect. A critical defect is a defect that judgment and experience indicate would result in hazardous or unsafe conditions for individuals using, maintaining, or depending on the item; or a defect that judgment and experience indicate is likely to prevent the performance of the major end item, i.e., the consumption of the ration.

(2) Major defect. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

(3) Minor defect. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.

Quality Assurance Provisions.

The following quality assurance criteria, utilizing ANSI/ASQC Z1.4-1993, Sampling Procedures and Tables for Inspection by Attributes, are required.

A. Classification of inspections. The inspection requirements specified herein are classified as follows:

(1) Production standard inspection. The first article or product demonstration model shall be inspected in accordance with the provisions of this Performance-based Contract Requirements and evaluated for overall appearance and palatability. Any failure to conform to the performance requirements or any appearance or palatability failure shall be cause for rejection.

SECTION E CONTINUED

(2) Conformance inspection. Conformance inspection shall include the product examination and the methods of inspection cited in this section.

B. Product examination. The finished product shall be examined for compliance with the performance requirements specified in Section C of this Performance-based Contract Requirements utilizing the double sampling plans indicated in ANSI/ASQC Z1.4 - 1993. The lot size shall be expressed in polymeric trays. The sample unit shall be the contents of one polymeric tray. The inspection level shall be S-3 and the AQL, expressed in terms of defects per hundred units, shall be 1.5 for major defects and 6.5 for minor defects. Defects and defect classifications are listed in Table I.

TABLE I. Product defects 1/ 2/ 3/

Category		Defect
Major	Minor	
		Appearance
101		Bone or bone fragment(s) measuring more than 0.3 inch in any dimension
102		Product not a uniform mixture of chicken pieces and vegetables in sauce
	201	Total weight of skin, cartilage, coarse connective tissue, tendons or ligaments, and discolored meat is more than 0.20 ounces
	202	Color of sauce not a translucent brown
	203	Color of vegetables not as specified
	204	Product does not contain kinds of vegetables as specified
	205	Vegetables pieces not discernible
	206	Color of chicken not of cooked chicken

SECTION E CONTINUED

TABLE I. Product defects 1/ 2/ 3/ (cont'd)

Category Major	Category Minor	Defect
		Odor and flavor
103		Chicken pieces do not possess mild poultry odor or flavor
104		Sauce does not possess a pleasing chow mein odor or flavor
		Texture
	207	Chicken pieces not moist or not tender
	208	Sauce not smooth or not moderately thick
	209	Vegetables not slightly soft to slightly firm
		Weight
	210	Net weight of an individual polymeric tray less than 90.0 ounces 4/
	211	Drained weight of chicken pieces in an individual polymeric tray less than 23.2 ounces 5/
	212	Drained weight of vegetables (combined) in an individual polymeric tray less than 20.8 ounces 6/

1/ Presence of any foreign material such as, but not limited to dirt, insect parts, hair, glass, wood, or metal, or foreign odors and flavors such as, but not limited to burnt, scorched, rancid, sour, stale, musty, or moldy shall be cause for rejection of the lot.

2/ Finished product not equal to or better than the approved first article, when applicable, or other approved model in palatability and overall appearance shall be cause for rejection of the lot.

SECTION E CONTINUED

3/ Dicer size requirement for chicken pieces shall be verified by certificate of conformance. Natural proportions of chicken used shall be verified by certificate of conformance.

4/ If the sample average net weight is less than 92.0 ounces, the lot shall be rejected.

5/ If the sample average drained weight of chicken is less than 25.2 ounces, the lot shall be rejected.

6/ If the sample average drained weight of vegetables is less than 22.8 ounces, the lot shall be rejected.

C. Methods of inspection.

(1) Commercial sterility. The sample size shall be one filled, sealed, and processed polymeric tray selected from each processed batch in the lot. Incubate the sample trays at 95°F ± 5°F for 10 days, unless other-wise specified by the inspection agency. Any evidence of swelling or microbial activity following incubation shall be cause for rejection of the lot.

(2) Shelf life. Compliance with shelf life requirement for product packaged in a type I polymeric tray (see MIL-PRF-32004)shall be determined by incubation for 18 months at 80°F and 60% RH. Compliance with shelf life requirement for product packaged in a type II polymeric tray (see MIL-PRF-32004) shall be determined by incubation for 36 months at 80°F and 60% RH.

(3) Net weight. The net weight of the filled and sealed polymeric tray shall be determined by weighing each sample unit on a suitable scale tared with a representative empty polymeric tray and polymeric tray cover. Results shall be reported to the nearest 0.1 ounce.

(4) Drained weight test. To determine drained weight, the free liquid in the polymeric trays shall be poured off and the remaining contents shall be poured into a flat-bottom container. A minimum of three times the polymeric tray's volume of 180°F to 190°F water shall be added to the container so as to cover the contents. The contents and water shall be gently agitated such as to liquefy rendered fat and remove the sauce without breaking the chicken

SECTION E CONTINUED

pieces or vegetables. The contents shall then be poured into a U.S. Standard No. 7 sieve in a manner that will distribute the product over the sieve without breaking the chicken pieces and vegetables. Sieve area shall be such that the distributed product does not completely cover all the openings of the sieve. The sieve shall be tilted at such an angle so as to assure complete drainage of all liquid from the product. The product shall be drained for 2 minutes before determining the drained weight by subtracting the sieve tare weight from the gross weight. The drained weight shall be reported to the nearest 0.1 ounce.

(5) Nutrient content. The sample to be analyzed shall be a composite of three filled and sealed polymeric trays which have been selected at random from the lot. The composited sample shall be prepared (see NOTE) and analyzed for protein content, fat content, and salt content in accordance with the following methods of the Official Methods of Analysis of AOAC International:

Test	Method Number
Protein	988.05
Fat	925.32
Salt	935.47

Test results shall be reported to the nearest 0.1 percent. Any result not conforming to the requirements specified in Section C of this Performance-based Contract Requirements shall be cause for rejection of the lot.

NOTE: The USDA will use AOAC method 983.18 for preparation of the sample.

SECTION J REFERENCE DOCUMENTS

MILITARY SPECIFICATION

MIL-PRF-32004 - Packaging of Food in Polymeric Trays

NON-GOVERNMENTAL STANDARDS

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

ANSI/ASQCZ1.4-1993 - Sampling Procedures and Tables for Inspection by Attributes

AOAC INTERNATIONAL

Official Methods of Analysis of the AOAC International

Appendix #5

INCH-POUND

MIL-PRF-32004
23 May 1997

PERFORMANCE SPECIFICATION

PACKAGING OF FOOD IN POLYMERIC TRAYS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance criteria for packaging materials and the packaging of food in polymeric trays to include the filling and hermetic sealing of the tray, the processing of the filled and sealed tray, and the application of a protective sleeve for the tray and lid. The combination of the tray and tray lid is referred to as the container.

1.2 Classification. Packaged and processed products will be of the following types and classes, as specified (see 6.1).

1.2.1 Types. The types of tray materials are as follows:

Type I - without oxygen absorbant additive (18 month at 80°F shelf life)
Type II - with oxygen absorbant additive (36 month at 80°F shelf life)

1.2.2 Classes. The classes of processing are as follows:

Class 1 - For retortable products
Class 2 - For hot-filled products
Class 3 - For oven-baked products

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Soldier Systems Command, Natick Research, Development, and Engineering Center, ATTN: SSCNC-WRE, Natick, MA 01760-5018 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 89GP

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in section 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 4 of this specification, whether or not they are listed.

2.2 Government documents. None.

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.1).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 999 - Methods of Vibration Testing of Shipping Containers

D 1974 - Methods of Closing, Sealing and Reinforcing Fiberboard Shipping Containers

D 3985 - Oxygen Gas Transmission Rate Through Plastic Film and Sheeting Using a Coulometric Sensor

D 5118 - Fabrication of Fiberboard Shipping Boxes

D 5276 - Test method for Drop Test of Loaded Containers by Freefall

F 1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

(Application for copies should be addressed to the American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive , West Conshohocken, PA 19428)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Performance characteristics.

3.1.1 Tray configurations and dimensions. Tray material shall be fabricated into trays as specified in figure 1. The tray shall have a minimum capacity of 96 fluid ounces.

3.1.2 Oxygen gas transmission rate.

3.1.2.1 Type I tray material. The oxygen gas transmission rate (O_2GTR) of the material shall not exceed 0.01 cc/100 sq. in./24 hrs.

3.1.2.2 Type II tray material (Class 1 and 2 only). The O_2GTR of the material shall not exceed 0.01 cc/100 sq. in./24 hrs. The material shall also have the added capability to control (absorb) oxygen permeation through the tray walls as well as headspace oxygen within the filled, sealed, and processed tray throughout the 36 months at 80°F shelf life of the tray product.

3.1.2.3 Tray lid. The O_2GTR of the material (types I and II) shall not exceed 0.0039 cc/100 sq. in./24 hrs/atm.

3.1.3 Water vapor transmission rate.

3.1.3.1 Tray material. The water vapor transmission rate (WVTR) of the material shall not exceed 0.69 cc/100 sq. in./24 hrs.

3.1.3.2 Tray lid. The WVTR of the material shall not exceed 0.00064 cc/100 sq. in./24 hrs.

3.1.4 Processing. The tray and lid material shall be capable of withstanding the process specified in the applicable food document.

3.1.5 Lid material. The lid material shall be capable of hermetically sealing the tray filled with product.

3.1.6 Protective sleeve. The sleeve shall protect the tray, lid, and seals from physical damage. The maximum height of the filled, sealed and processed tray with protective sleeve shall not exceed 2-1/8 inches. The length of the protective sleeve shall cover the entire tray flange, and shall not exceed 12-3/4 inches. The width of the protective sleeve shall fit snugly against the tray flange so as to restrict the sliding motion of the tray within the sleeve. The top and bottom faces of the sleeve at the open ends shall be compressed in such a manner so as to keep the top sleeve face flush against the tray lid and seams. The tray shall be restrained within the sleeve in such a manner so as to prevent the tray from sliding out through an open end. The sleeve shall provide added stacking strength to the tray. The color of all inside and outside surfaces of the sleeve shall be natural kraft, tan, or dull gray. A label with the following instructions shall be printed,

stamped, or otherwise applied onto the protective sleeve, in a manner that does not damage the sleeve, with permanent ink of any contrasting color.

PROTECTIVE SLEEVE

DO NOT THROW AWAY

SAVE AND RE-USE TO PROTECT TRAY FROM DAMAGE

To Avoid Damaging Tray Lid:

1. Keep This Protective Sleeve Secured to Tray Until Ready to Heat, Then Remove.

2. Insert Tray Back Into Sleeve After Heating.

3. Always Use Sleeves When Transporting Trays in Insulated Containers.

4. If Sleeves Are Unavailable, Stack Trays Lid-to-Lid with Fiberboard Pads in Between.

3.1.7 Rough handling survivability. After processing, the filled and sealed container, with protective sleeve added, shall be capable of withstanding rough handling.

3.1.8 Residual gas. Residual gas volume in the filled, sealed and processed trays shall not exceed 175.0 cubic centimeters.

3.1.9 Closure seal. The closure seal shall be a minimum of 1/8 inch wide. The closure seal shall be continuous along the flange surface. The closure seal shall be free of impression or design on the seal surface. The closure seal shall be free of wrinkles, occluded matter, or evidence of entrapped moisture or grease.

3.1.10 Internal pressure. The filled, sealed and processed trays shall withstand an internal pressure of 20 psig.

3.1.11 Lid opening. The tray lid shall be easily removed with a knife.

3.1.12 Camouflage. The color of exterior surfaces of the tray and tray lid shall contribute to woodland camouflage (i.e., earth brown, black, olive drab, forest green, etc.).

4. VERIFICATION

4.1 Conformance inspection. Conformance inspection includes those examinations and tests from table I as defined in the contract or purchase order, performed on specified samples (see 6.1 and 6.2).

TABLE I. Verification methods

Characteristic 1/	Requirement	Verification
Tray configurations and dimensions	3.1.1	4.4.1
Oxygen gas transmission rate (Type I)	3.1.2.1	4.4.2
Oxygen gas transmission rate (Type II)	3.1.2.2	4.4.3
Water vapor transmission rate	3.1.3	4.4.4
Processing	3.1.4	4.4.5
Lid material	3.1.5	4.3
Protective sleeve	3.1.6	4.4.6
Rough handling survivability	3.1.7	4.4.7
Residual gas	3.1.8	4.4.8
Closure seal	3.1.9	4.3
Internal pressure	3.1.10	4.4.9
Lid opening	3.1.11	4.4.10
Camouflage	3.1.12	4.4.11

1/ In lieu of testing, determination of compliance to camouflage requirements may be ascertained by examination of records, invoices, or other valid documents. In addition, compliance to the requirements for O_2GTR, WVTR, processing, rough handling survivability, outside tray dimensions, and tray capacity may be verified by certificate of conformance.

4.2 Verification methods. The types of verification methods may be visual inspection, measurement, sample tests, full scale demonstration tests, simulation modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

4.2.1 Verification alternatives. The manufacturer may propose alternative tests methods, techniques, or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures to verify performance. The contract may specify alternatives that replace verifications required by this specification.

4.3 Examination of container. After processing, the container shall be visually examined for compliance with 3.1.4, 3.1.5, and 3.1.9. Defects and defect classifications are listed in table II.

TABLE II. Filled, sealed and processed container defects

Category				Defect
Critical	Major A	Major B	Minor	
1				Swollen container
2				Tear, crack, cut, hole, or if a multi-layered laminate is used, abrasion through more than one layer of the tray or through the barrier (e.g. foil) layer of the lid material or leakage through any seal or surface
3				Abrasion on the lid material within 1/16 inch of the food product edge of seal
4				Closure seal not continuous along tray flange
5				Closure seal width less than 1/8 inch
6				Foldover wrinkle extending into the seal such that the closure seal is reduced to less than 1/8 inch
7				Presence of entrapped matter (for example, product, moisture, grease, etc.) that reduces the closure seal to less than 1/8 inch

TABLE II. Filled, sealed and processed container defects (cont'd)

Category				Defect
Critical	Major A	Major B	Minor	

8				Presence of delamination when a multi-layered laminate is used 1/
	101			Unclean container 2/
	102			Any impression or design on the seal surfaces which conceals or impairs visual detection of seal defects
		151		Presence of delamination when a multi-layered laminate is used 1/
			201	Presence of delamination when a multi-layered laminate is used 1/
			202	Color does not contribute to woodland camouflage

1/ Delamination defect classification:

Critical - Evidence of outer ply delamination such that the adjacent ply in the lid body is exposed or evidence of two ply delamination such that the food contact layer is exposed. Any evidence of outer ply delamination for the tray body.

Major B - Delamination of the outer ply in the lid seal area that can be propagated to expose the adjacent ply at the food product edge of the lid. The separated outer ply shall be grasped between thumb and forefinger and gently lifted toward the food product edge of the seal or if the separated area is too small to be held between thumb and forefinger, a number two stylus shall be inserted into the delaminated area and a gentle lifting force applied against the outer ply. If separation of the outer ply can be made to extend to the product edge of the seal with no discernible resistance to the gentle lifting, the delamination shall be scored as a Major B defect. Additionally, spot delamination of the outer ply in the body of the lid that is able to be propagated beyond its initial borders is also a Major B defect. To determine if the delaminated area is a defect, use the following procedure: Mark the outside edges of the delaminated area using a bold permanent marking pen. Open the tray and remove the contents. Cut the lid transversely not closer than 1/4 inch (± 1/16 inch) from the delaminated area. Hold the delaminated area between the thumb and forefinger of each hand with both thumbs and forefingers touching each other. The delaminated area shall then be rapidly flexed 10 times by rotating both hands in alternating clockwise-counter clockwise directions. After flexing, the separated outer ply shall be grasped between thumb and forefinger and gently lifted away from the lid surface or if the separated area is too small to be held between thumb and forefinger, a number two stylus shall be inserted into the delaminated area and a gentle lifting force applied

against the outer ply. Any propagation of the delaminated area, as evidenced by the delaminated area exceeding the limits of the outlined borders, shall be scored as a Major B defect.

Minor - Minor delamination of the outer ply in the lid seal area is acceptable and shall not be classified as a minor defect unless it extends to within 1/16 inch of the food product edge of the seal. Isolated spots of delamination in the body of the lid that do not propagate when flexed as described above shall be classified as minor.

2/ Scale or dust on the outside of container caused by retort water may be removed by washing. The following examples shall not be scored as defects for unclean:

a. Water spots.

b. Ten or less specks of dried product each of which measure 1/8 inch by 1/8 inch or equivalent area, or less.

c. Any foreign matter which presents no health hazard or no potential container damage and which readily falls off when container is lifted and shaken lightly.

d. Very thin film of grease, oil, or product residue which is discernible to touch, but not readily discernible by visual examinations.

e. Thin strips or drops of adhesive.

4.4 Tests.

4.4.1 Tray configurations and dimensions. Prior to filling, sealing and processing, tray dimensions shall be measured and compared to the requirements of figure 1. The tray shall be placed on a flat surface and filled with 96 fluid ounces of water. Any tray dimension exceeding the requirements of figure 1; or tray which cannot hold a minimum of 96 fluid ounces of water shall be considered a test failure.

4.4.2 Oxygen gas transmission rate (Type I). The O_2GTR of the material shall be determined in accordance with ASTM D 3985 at 73°F and 50 % relative humidity.

4.4.3 Oxygen gas transmission rate (Type II). The O_2GTR of the material shall be determined in accordance with ASTM D 3985 at 73°F and 50 % relative humidity. An added capacity to absorb headspace oxygen within the filled, sealed, and processed tray as well as oxygen permeation through the tray walls for a minimum of 36 months at 80°F shall be verified by certificate of conformance.

4.4.4 Water vapor transmission rate. The WVTR of the material shall be determined in accordance with ASTM F 1249 at 104°F and 90 % relative humidity.

4.4.5 Processing. Testing for processing of the material shall be as follows: Material shall be formed into trays in accordance with figure 1. For Class 1, trays shall be filled with approximately 96 ounces of water, sealed with the tray lid material, and exposed to the same processing conditions as required by the food product document. For Class 2 and 3, trays shall be filled and sealed with representative product in accordance with the appropriate food product document. Following processing, containers shall be examined in accordance with table II.

4.4.6 Protective sleeve. The protective sleeve with filled, sealed and processed tray inside shall be placed on a flat surface and examined for conformance to dimension, labeling, and stacking strength requirements. Any sleeved trays with a height greater than 2-1/8 inches; or sleeves not covering the entire flange length; or sleeves exceeding 12-3/4 inches in length; or sleeves not preventing sliding of the tray along the sleeve width; or sleeves not compressed in such a manner as to keep the top sleeve face flush against the tray seal surfaces; or sleeves that do not prevent the tray from sliding out through an open end; or sleeves not providing added stacking strength equivalent or better than a sleeve constructed of grade 275 fiberboard in accordance with ASTM D 5118 and with flutes oriented parallel to the sleeve width; or sleeves not of a natural kraft, tan or dull gray color; or label instructions missing; or label instructions not legible shall be considered a test failure.

4.4.7 Rough handling survivability.

4.4.7.1 Standard temperature test. Four trays, filled with a representative food product, processed and prepared as specified in the applicable food document shall be inserted into the protective sleeve as specified in 3.1.6 and packed in a snug fitting fiberboard box conforming to style RSC-L, type CF, grade 275 of ASTM D 5118. The sleeved trays shall be placed flat with the first two trays placed with the lids together and the next two trays with the lids together. The inside of each box shall be provided with a box liner. The height of the box liner shall be equal to the full inside depth of the box (+ 0 inch, - 1/8 inch). The box shall be closed in accordance with ASTM D 1974. Condition the box of four trays in an atmosphere uniformly maintained at 72°F ± 2°F for a period of 48 hours. Conduct a drop test in accordance with ASTM D 5276, Assurance Level I for a series of 10 drops, to include: (1) a bottom corner drop at the manufacturer's joint; (2 & 3) edge drops on the shortest and next shortest edges radiating from the corner; (4) an edge drop on the longest edge radiating from that corner; (5 & 6) flatwise drops on the smallest and opposite smallest faces; (7 & 8) flatwise drops on the medium and opposite medium faces; (9 & 10) flatwise drops on the longest and opposite longest faces. Immediately after completion of the drop test, conduct a vibration test (on the same box of four trays) in accordance with ASTM D 999, at 268 RPM for a period of one hour. Remove trays from the box and examine visually. Any cracked, split or broken tray or lid at

any location; or closure seal width less than 1/8 inches; or tear, hole, or puncture through protective sleeve causing a hole in the tray lid; or obviously wet or stained protective sleeve due to leaking trays; or any evidence of food product leakage from tray or lid; or absence of protective sleeve; or protective sleeve no longer preventing the tray from sliding out through an open end shall be considered a test failure.

4.4.7.2 Frozen temperature test. Prepare the box of four trays as specified in 4.4.7.1, but condition in an atmosphere uniformly maintained at -20°F ± 2°F for a period of 48 hours. While still in frozen state, conduct drop and vibration tests as specified in 4.4.7.1. Remove trays from the box and allow to fully thaw prior to visual examination. Any cracked, split or broken tray at any location, except along the outermost flange edges, or lid at any location; or closure seal width less than 1/8 inches; or tear, hole, or puncture through protective sleeve causing a hole in the tray lid; or obviously wet or stained protective sleeve due to leaking trays; or any evidence of food product leakage from tray; or absence of protective sleeve; or protective sleeve no longer preventing the tray from sliding out through an open end shall be considered a test failure.

4.4.8 Residual gas volume. The samples for test shall be opened under 75°F ± 5°F water and the gases shall be collected by water displacement in a graduated cylinder or other calibrated tube. The volume of the gases shall be reported to the nearest 1 cubic centimeter. Any residual gas volume exceeding 175.0 cubic centimeters shall be considered a test failure.

4.4.9 Internal pressure. Internal pressure resistance shall be determined by pressurizing the container without protective sleeve while they are restrained between two rigid plates spaced 1-15/16 inch ± 1/16 inch apart. A four-seal tester (designed to pressurize filled container by use of a hypodermic needle through the container wall or lid) shall be used and all four seals tested simultaneously. Pressure shall be applied at the approximate uniform rate of 1 psig per second until 20 psig pressure is reached. The 20 psig pressure shall be held constant for 30 seconds and then released. The container then shall be examined for separation or yield of the heat seals. Any rupture of the container or evidence of any seal separation that reduces the effective closure seal width to less than 1/8 inch shall be considered a test failure.

4.4.10 Lid opening. Place a filled, sealed and processed tray on a flat surface and remove the protective sleeve, if necessary. Position one hand along the tray flange and use a knife in the other hand to cut open the lid along the inside edge of the complete tray flange, approximately 1/4 inches away from the flange edge. The inability to open the lid in the manner described herein shall be considered a test failure.

4.4.11 Camouflage. Visually examine the exterior surfaces of the tray and tray lid after processing.

5. PACKAGING

This section is not applicable to this specification.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Type and class required (see 1.2).

c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1 and 2.3).

d. Sampling for conformance inspection (see 4.1).

6.2 Conformance inspection. Affordable conformance inspection with confidence varies depending upon a number of procurement risk factors. Some of these factors include contractor past performance, government schedules and budget, product material and design maturity, manufacturing capital equipment and processes applied, the controlled uniformity of those processes, labor skill and training, and the uniformity of measuring processes and techniques. During the solicitation, contracting documents should indicate those tests desired from table I and their designated frequency based on a risk assessment for the procurement.

6.3 Tray material.

6.3.1 Type I material. The U.S. Army Soldier Systems Command (SSCOM), Natick Research, Development and Engineering Center (NRDEC) has found that a seven layer coextruded structure consisting of polypropylene, regrind, tie, ethylene vinyl alcohol (EVOH), tie, regrind, and polypropylene, when formed into a tray with a minimal wall thickness of 0.022 inches, a tray weight of 125 grams ± 12 grams, an EVOH content of 6 percent, and a minimum EVOH barrier layer thickness of 0.001 inches meets the performance criteria of this specification. A polymeric tray (Drawing #9212, Revision B) constructed of the above material is available from Rexan Containers, Union, MO 63084.

6.3.2 Type II material. SSCOM (NRDEC) has found that the type I material structure (see 6.3.1) modified to include a 30% loading of Amosorb® oxygen scavenger additive (a product of Amoco Chemical Company) meets the performance criteria of this specification.

6.4 Lid material. SSCOM (NRDEC) has found that a lid material structure consisting of, from inside to outside, 0.003 to 0.004 inch thick polyolefin, 0.00035 to 0.0007 inch thick aluminum foil

and 0.0005 inch thick polyester meets the performance criteria of this specification. However, SSCOM (NRDEC) has observed that during rough handling testing at -20°F (see 4.4.7.2), the possibility exists that the lidding material may pinhole, puncture, or develop raised bumps from frozen food product within the tray. Care should be taken to minimize the handling of polymeric trays when frozen.

6.5 Protective sleeve material. SSCOM (NRDEC) has found that a protective sleeve material constructed of grade 275 fiberboard in accordance with ASTM D 5118, oriented with flutes parallel to the sleeve width, jointed and hot melt glued along the vertical length of the sleeve, and securely taped around the entire sleeve and across the open ends at their midpoint meets the performance criteria of this specification.

6.6 Technical information. Specific technical inquires may be addressed to the Commander, U.S. Army Soldier Systems Command, Natick Research, Development and Engineering Center, ATTN: SSCNC-WRE, Natick, MA 01760-5018.

6.7 Subject term (key word) listing.

Combat field feeding
Operational rations

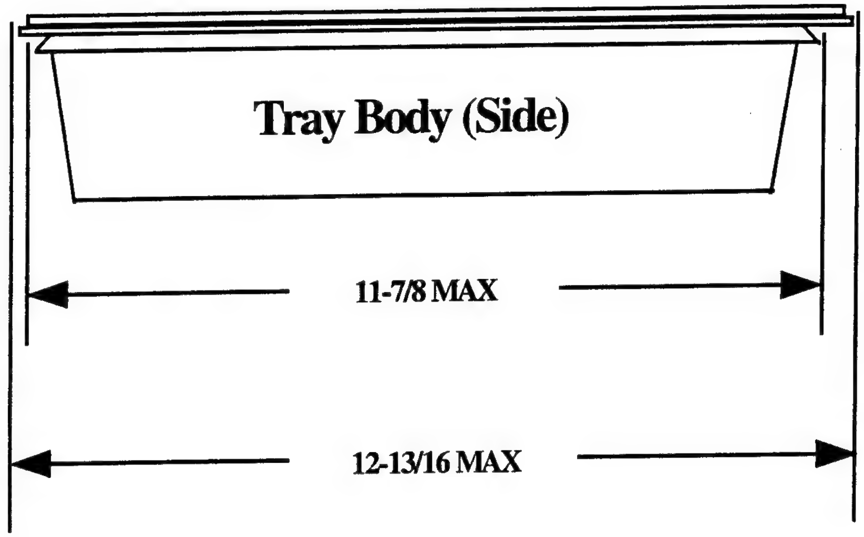
Custodians:
Army - QM
Navy - MC

Review activities:
Army - MD
Navy - SA
DLA - SS

Civil agency coordinating activity:
USDA - FV

Preparing activity:
Army - GL

(Project 89GP-0137)


Tray Body (Side)
11-7/8 MAX
12-13/16 MAX

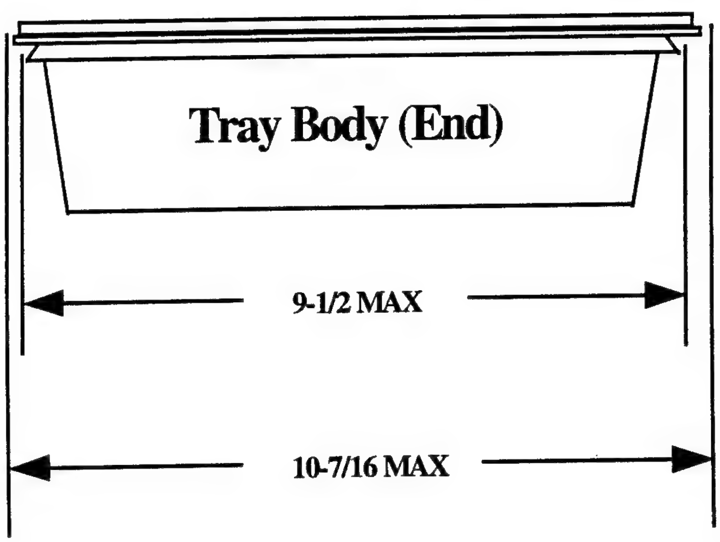

Tray Body (End)
9-1/2 MAX
10-7/16 MAX

FIGURE 1: Dimensional Requirements for the Polymeric Tray.
All Dimensions are in Inches.

Appendix #6

SUPPLEMENTAL INFORMATION

QUALITY ASSURANCE PROVISIONS AND PACKAGING REQUIREMENTS FOR MIL-PRF-32004 PACKAGING OF FOOD IN POLYMERIC TRAYS

NOTICE TO CONTRACTING OFFICER In view of the fact that the ANSI/ASQC Z1.4-1993 standard does not contain the definitions for critical, major, and minor defects, it is important that they become contractually binding through the contract.

I. DEFINITIONS

A. Critical defect. A critical defect is a defect that judgment and experience indicate would result in hazardous or unsafe conditions for individuals using, maintaining, or depending on the item; or a defect that judgement and experience indicates is likely to prevent the performance of the major end item, i.e., the consumption of the product.

B. Major defect. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

C. Minor defect. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.

II. QUALITY ASSURANCE

A. Quality assurance criteria. The following quality assurance criteria, utilizing ANSI/ASQC Z1.4-1993, Sampling Procedures and Tables for Inspection by Attributes are recommended. The paragraph numbers listed below relate to the applicable paragraph in the specification (MIL-PRF-32004).

1. 4.1 Container testing. The container and container material shall be examined for the characteristics listed in table I. The lot size, sample unit, and inspection level criteria are provided for each of the test characteristics. Any test failure shall be classified as a major defect and shall be cause for rejection of the lot.

TABLE I. Container quality assurance criteria

Characteristic	Lot size unit	Sample unit	Inspection level
Tray configurations and dimensions	1 tray	1 tray	S-1

QUALITY ASSURANCE PROVISIONS AND PACKAGING REQUIREMENTS FOR MIL-PRF-32004 PACKAGING OF FOOD IN POLYMERIC TRAYS

TABLE I. Container quality assurance criteria (cont'd)

Characteristic	Lot size unit	Sample unit	Inspection level
Oxygen gas transmission rate - tray	1 tray	1 tray	S-1
Oxygen gas transmission rate - lid	1 yard	½ yard	S-1
Water vapor transmission rate - tray	1 tray	1 tray	S-1
Water vapor transmission rate - lid	1 yard	½ yard	S-1
Processing	1 tray	1 tray	S-2
Rough handling survivability	1 test container	1 test container	S-2
Residual gas	1 container	1 container	S-1
Closure seal	1 container	1 container	S-1
Internal pressure	1 container	1 container	S-1
Lid opening	1 container	1 container	S-1
Camouflage	1 container	1 container	S-1

2. 4.3 Examination of container. The container with protective sleeve removed shall be examined for the defects listed in table II of MIL-PRF-32004. The lot size shall be expressed in containers. The sample unit shall be one processed container. The inspection level shall be I and the acceptable quality level (AQL), expressed in terms of defects per hundred units, shall be 0.65 for major A defects, 2.5 for major B defects, and 4.0 for minor defects. Two hundred sample units shall be examined for critical defects. The finding of any critical defect shall be cause for rejection of the lot.

QUALITY ASSURANCE PROVISIONS AND PACKAGING REQUIREMENTS FOR MIL-PRF-32004 PACKAGING OF FOOD IN POLYMERIC TRAYS

3. Shipping container examination. The filled and sealed shipping containers shall be examined for the defects listed below. The lot size shall be expressed in shipping containers. The sample unit shall be one shipping container fully packed. The inspection level shall be S-3 and the AQL, expressed in terms of defects per hundred units, shall be 4.0 for major defects and 10.0 for total defects.

Major: National stock number, item description, contract number, name and address of producer, or date of pack missing, incorrect, or illegible
Container not closed properly
Protective sleeve missing

Minor: Other required markings missing, incorrect, or illegible
Arrangement or number of polymeric trays not as specified

4. Unit load examination. The unit loads shall be examined for the defects listed in table II. The lot size shall be expressed in units of unitized or containerized unit loads. The sample unit shall be one unitized or containerized unit load. The inspection level shall be S-4 and the AQL, expressed in terms of defects per hundred units, shall be 4.0.

TABLE II. Unit load defects

Examine	Defect
Pad	Material not as specified
	Missing
Pallet	Size not as specified
	Type not as specified
Bonding method	Missing, broken, or not as specified
Load dimensions	Dimensions exceeded
Marking	Missing, incorrect, or illegible

III. PACKAGING

A. Packaging. The following packaging requirements are recommended.

1. Labeling and marking.

a. Tray. One side of each tray shall be clearly printed or stamped, in a manner that does not damage the tray, with permanent black ink or any other contrasting color, which is free of carcinogenic elements or ingredients. To avoid erroneous marking of trays, the product name,

lot number and filling equipment number shall be applied prior to processing. All other marking may be applied before or after processing.

(1) Product name. Commonly used abbreviations may be used when authorized by the inspection agency.

(2) Tray code includes: 1/
Lot Number
Filling equipment identification number
Retort identification number 2/
Retort cook number 2/

1/ Shall be code marked as follows: The lot number shall be expressed as a four digit Julian code. The first digit shall indicate the year of production and the next three digits shall indicate the day of the year (Example, March 19, 1995 would be coded as 5078). The Julian code shall represent the day the product was packaged into the container and processed. Sub-lotting (when used) shall be represented by an alpha character immediately following the four digit Julian code. Following the four digit Julian code and the alpha character (when used), the other required code information shall be printed in the sequence as listed above. For food products that do not require an establishment number, the Julian code shall be preceded by three capital letters, which represent the packer's name.
2/ Required only when retort process used

b. Tray lid. The lid shall be clearly printed or stamped, in a manner that does not damage the lid, with permanent black ink or any other contrasting color, which is free of carcinogenic elements or ingredients.

(1) Lid markings include: 1/
Product name
Ingredients
Heating and serving instructions as specified in the appropriate food product specification
Listed in each spec
Net weight
Name and address of packer
Code (same as tray code)
USDA approval stamp for the packers plant (applicable to meat and poultry items only)
~~FDA~~ "Nutrition Facts" Label in accordance with the Nutrition Labeling and Education Act (NLEA)

QUALITY ASSURANCE PROVISIONS AND PACKAGING REQUIREMENTS FOR MIL-PRF-32004 PACKAGING OF FOOD IN POLYMERIC TRAYS

1/ As an alternate lid labeling method, a pre-printed self-adhering 0.002 inch thick clear polyester label printed with indelible black or other contrasting color ink may be used.

c. Shipping containers. Shipping containers shall be marked as specified in the contract or purchase order. As a minimum, the following information shall appear on each shipping container:

National Stock Number (NSN)
Item Description
Contract or Purchase Order No.
Name and Address of Producer
Date of Pack (month/year)

d. Unit loads. Unit loads shall be marked in accordance with DPSC Form 3556 Marking Instructions for Shipping Cases, Sacks and Palletized/Containerized Loads of Perishable and Semiperishable Subsistence.

2. Packing.

a. Packing for shipment to ration assembler. Four filled, sealed, processed and sleeved trays shall be packed in a snug fitting fiberboard box conforming to style RSC-L, type CF, grade 275 of ASTM D 5118, Fabrication of Fiberboard Shipping Boxes. The sleeved trays shall be placed flat with the first two trays placed with the lids together and the next two trays with the lids together. The inside of each box shall be provided with a box liner. The height of the box liner shall be equal to the full inside depth of the box (+ 0 inch, - 1/8 inch). Flute direction of the box liner shall be vertical. The box shall be closed in accordance with ASTM D 1974, Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Shipping Containers.

b. Unit loads. Shipping containers shall be arranged on a 40 x 48 inch or on a 48 x 40 inch flush or double wing, partial 4 way entry commercial wood pallet. A 40 x 48 inch commercial fiberboard pad shall be positioned on the pallet before loading. Each prepared load shall be bonded with nonmetallic strapping, or shrink film, or stretch film. When strapping is used, the straps shall pass under the top deck boards. When stretch or shrink film is used, it must be applied low enough on the pallet to bond the load to the pallet. Unit load dimensions shall not exceed either 43 inches in length by 52 inches in width by 54 inches in height; or 52 inches in length by 43 inches in width by 54 inches in height.

COMBAT RATION NETWORK

FOR

TECHNOLOGY IMPLEMENTATION

Poly Tray Packaging Evaluations

Final Technical Report STP 1002C

Results and Accomplishments (January through November 1999)

Report No: FTR 104

CDRL Sequence: A004

February 2000

CORANET CONTRACT NO. SPO103-96-D-0016

Sponsored by:
DEFENSE LOGISTICS AGENCY
8725 John J. Kingman Rd.
Fort Belvoir, VA 22060-6221

Contractor:
Rutgers, The State University of New Jersey
THE CENTER FOR ADVANCED FOOD TECHNOLOGY
Cook College
N.J. Agricultural Experiment Station
New Brunswick, New Jersey 08903

Principal Investigator:
Jeffrey S. Canavan

Dr. John F. Coburn
Program Director

TEL: 732-445-6130
FAX: 732-445-6145

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	February 1999	

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Poly Tray Packaging Evaluations (Short Term Project - 1002C)	SP0103-96-D-0016 PE - 7811s PR - ~~88003~~ 96004
6. AUTHOR(S) Jeffery S. Canavan	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Rutgers, The State University of New Jersey The Center for Advanced Food Technology Cook College, NJ Agricultural Experiment Station New Brunswick, NJ 08903	8. PERFORMING ORGANIZATION REPORT NUMBER FTR 104
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Defense Logistics Agency 8725 John J. Kingman Road Ft. Belvoir, VA 22060-6221	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

On April 6.7, 9. and 12, 1999 at Rutgers University FMT Facility, Piscataway, NJ, a production test for replacement of the metal tray-can with the polymeric tray was conducted to quantify the manufacturability of a baked product under documented production conditions. Better control of sealing widths was obtained with wider carrier sealing rubbers and tighter mechanical tolerances. Seal widths and entrapped material were the major sealing defect causes.

Experimental production data was used in a simulation program to estimate commercial level production rate costs of the tray-can, poly tray with insert, and foil pouch pack. Non-traditional Capital Investment Criteria, (NCIC), provided additional insight into the value of each container by incorporating the relationship between ranked elements and cost. For a yearly production of 200,000 cakes, the estimate benefit of the polytray package would be $199,500.

14. SUBJECT TERMS	15. NUMBER OF PAGES
	34
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)

Table of Contents

1 Introduction

The objective of this project was to produce, using the facilities of the CORANET Demonstration Site at Rutgers University (Food Manufacturing Technology Facility), a statistically significant quantity of the heat-sealed military design polymeric trays containing specified, military, baked cakes for testing and acceptance by NATICK and the Services. Specific tasks required to meet the overall objective included active participation by NATICK, RUTGERS and CORANET Partner STERLING FOODS. The CORANET Demonstration Site (FMT Facility) continues to support NATICK in production tests. The processes and equipment used and the results obtained will be available without limitation to any of the combat ration producers DSCP may contemplate for future contracts.

2 Background

The Services are in the process of changing their heat-and-serve package for use in group-serving military field feeding from a metal traypack can to a polymeric tray. Manufacturability analysis of production test runs along with Natick Soldier Center (NATICK) laboratory and field testing of performance provided the basis for acceptance. The Services have requested that Cake products also be packaged in a polymeric tray rather than in an alternate institutional-size foil-laminate pouch. In order to use the same polymeric tray as that for entrée items, it is necessary, because of temperature limitations, to employ a paperboard insert for the baking stage followed by placement into the standard polymeric tray for sealing and long-term storage. The feasibility of such an approach has been successfully demonstrated at NATICK albeit under Laboratory scale and conditions.

Additionally, a producibility issue related to the polymeric tray has been identified, in part from the analysis of trays produced at the Rutgers Food Manufacturing Technology Facility (FMTF) under CORANET STP #1002. Specifically, an adhesion problem exists between internal layers of the Type II tray, resulting in a gradual build-up of moisture. This build-up of moisture manifests itself as a blister in the tray corners, which although mostly cosmetic in nature, will likely affect the Soldier acceptance of the item, and may impact on long term shelf life. NATICK and Rexam Containers (manufacturer of the polymeric tray) were tasked with eliminating this blistering problem prior to the upcoming procurement of polymeric tray retort food items by Defense Supply Center Philadelphia (DSCP). Rexam Containers completed the retooling of the their polymeric tray forming equipment, so as to facilitate the full-scale production of the military desired rounded corner, reinforced tray design. Trays of this particular design had yet to be filled, loaded into carriers, and sealed using the Heat Sealer at the FMT Facility.

The Raque Heat Sealer located at the FMT Facility is currently producing commercial polymeric trays filled with Macaroni & Cheese at the rate of 15 trays per minute (limit depends on specific product fill-rate capability). The FMT Facility and the Heat Sealer were used earlier for CORANET Producibility tests of Chicken Chow Mein and of Pork Sausage Links with Brine, both packed into Rexam polymeric trays. In order to cost/effectively and quickly establish certain production details, it was desirable that Rutgers and NATICK partner with Sterling Foods. Technology provided by Sterling Foods, such as batter composition, preparation, etc. and handling which was not apparent to the production test observer, will not be disclosed.

Summary

On April 6,7, 9, and 12, 1999 at the Rutgers University FMT Facility, Piscataway, NJ, a production test for replacement of the metal tray-can with the polymeric tray was conducted to quantify the manufacturability of a baked product under documented production conditions. Better control of sealing widths was obtained with wider carrier sealing rubbers and tighter mechanical tolerances. Seal widths and entrapped material were the major sealing defect causes.

Experimental production data was used in a simulation program to estimate commercial level production rate costs of the tray-can, poly tray with insert, and foil pouch pack. Non-traditional Capital Investment Criteria. (NCIC), provided additional insight into the value of each container by incorporating the relationship between ranked elements and cost. For a yearly production of 200,000 cakes, the estimate benefit of the polytray package would be S199,500.

Production and Manufacturability of Cakes in Poly-trays

Production of 688 cakes for the project occurred over four days. Cake batter and crumb ingredient batches were delivered by Sterling Foods of San Antonio, TX, to the Rutgers University FMT Facility, Piscataway, NJ, where the production took place on April 6,7,9, and 12, 1999. Each 20-cake batter batch was prepared in a commercial 60 quart Welbilt varimixer following Sterling Foods' procedure to obtain the recommended batter specific gravity. The topping batches were prepared separately in the same mixer beforehand and refrigerated until needed. As each batter batch was completed, it was poured and spatulaed into the hopper of a Raque piston filler. The filler was calibrated to deliver the required weight of batter that was individually check-weighed as weight was corrected into hand-glued, poly-coated, cardboard baking inserts provided by Westvaco. After being check-weighed, a pre-measured amount of crumb topping was drizzled uniformly onto the cake top and manually flattened out before each insert was racked on baking trays. Once a batch was racked, it was wheeled into the baking room and baked for a period and temperature outlined by Sterling Foods in gas-fired commercial convection ovens. After baking, the trays were re-racked and rolled in the staging area to cool to the recommended temperature range. Once cooled, the cakes were loaded into the Rexam Type II poly-trays that had the four oxygen scavengers, supplied by Sterling Foods, already in place. Each tray lip was wiped thoroughly by hand with a lint-free paper towel. Trays were then loaded into the Raque Heat Sealer carriers and sealed using Smurfit tri-laminate foil film. As the trays left the conveyor, they were stacked to protect the sealing area from damage due to handling since inspection would occur offline. Each tray was individually visually inspected by Lee Brothers, Inspector-In-Charge, USDA, AMS, FV, PPB, @Sterling Foods, following production. Once all samples and rejects were packed and shipped, the remainder of the production run was cartoned and palletized for shipment.

General issues

The blistering problem seen during previous production runs has been greatly reduced. Use of wider carrier sealing rubbers and better carrier to head alignment allowed for more uniform seal widths.

Supply problems with the tray inserts caused production delays. Once sufficient quantity of baking inserts was obtained, each tray corner had to be glued together by hand. To order the necessary capital improvement to automate the prefabrication of the trays was beyond the scope of this project, so the manual technique was used.

Sterling Foods provided pre-weighed batter and crumb topping batches for the production run. The entire short shipment was depleted to produce 688 cakes.

During production, the baked cakes were placed into the polytrays just before sealing. The cakes were cooled to reach the Natick's recommended internal temperature before sealing. The cooling step might be unnecessary. Elimination of the cooling step would reduce handling and potential damage and staging space required for the in-process material flow. Further study on this process requirement is recommended.

Transferring the cooled cakes into the insert to the trays caused neither difficulty nor significant cake damage. However, after the transfer step, it was necessary to wipe thoroughly the tray sealing lip of crumb topping. The wiping process took longer than the transfer and was not entirely effective since small crumbs would 'jump' back onto the lip from static electrical attraction. Increasing room humidity in the process area could reduce static energy.

Tray inspection should be done immediately following sealing. The cakes from rejected containers could then be removed and resealed while still warm. During the production tests, inspection was done after the cakes had cooled down completely and could not be resealed.

FMT Facility specific issues

Originally, a Jet-Sweep Enersyst continuous oven was to be used to bake the cakes, since it would better simulate a full-scale production process. However, in testing the Enersyst's baking throughput, it was determined that at the slowest conveyor speed, with the slowest available motor, the residence time of one cycle would be insufficient for complete baking. At the lowest conveyor speed, the cakes would have to be fed through the oven twice. Since this would significantly extend the production schedule, and increase the risk of damage from handling, four commercial convection batch ovens were used that each could hold an entire 20-cake batter batch.

The batch ovens shifted the process bottleneck to the batter prep and filling operation, so production of the 688 cakes was finished in four days. Unfortunately, the batch ovens' internal temperature distributions were not completely uniform. Cakes from the same batch would not be uniformly baked even when the baking trays were shifted around during the baking cycle. Variation in temperature from oven to oven also decreased baking consistency.

The oxygen scavengers were placed under the inserts during production. Oxygen absorption rates were significantly slower than had the absorbers been placed directly on top of the cake in the headspace. While the oxygen content of the headspace ultimately reached acceptable levels, it took longer than specifications allowed. Scavengers should be placed on top to reduce the oxygen content per specifications.

To expedite the project, ingredient batches for the batter and topping were obtained from Sterling Foods. Since a relatively small sized commercial mixer was used for preparing the batter, variation was evident between batches. Even when the same procedure outlined by Sterling was carried out to obtain the correct batter specific gravity, the batter still exhibited differing levels of grain structure and uniformity. Seal contamination from the crumb topping increased with larger cake heights. Tighter control over the batter preparation and baking process would allow better control of the cake height and subsequent crumb spillage.

Simulation Modeling

Summary

The simulation cost model estimate for commercial-scale production of the metal can, polytray with insert, and pouch pack were $4.21, $4.15, and $4.29 respectively. For the small batch processing simulations, the costs were $5.96, $5.88, and $6.04, respectively.

Simulation Modeling

Two computer programs, Optima and iGrafx Process, were used to produce the six different case studies. With it, virtual assembly lines were created. Each production step was assigned resources, costs, and process times that were used to track materials through the complete process model. For each large-scale scenario, the resources were optimized to forecast capital equipment needs to sustain adequate and equal production utilization for each of the lines. The bottleneck in each of the commercial production studies was shifted to the packaging line. The small batch cases represent estimates based on present equipment at the FMT Facility and measured production rates. In all cases, material costs were based on large-scale order pricing.

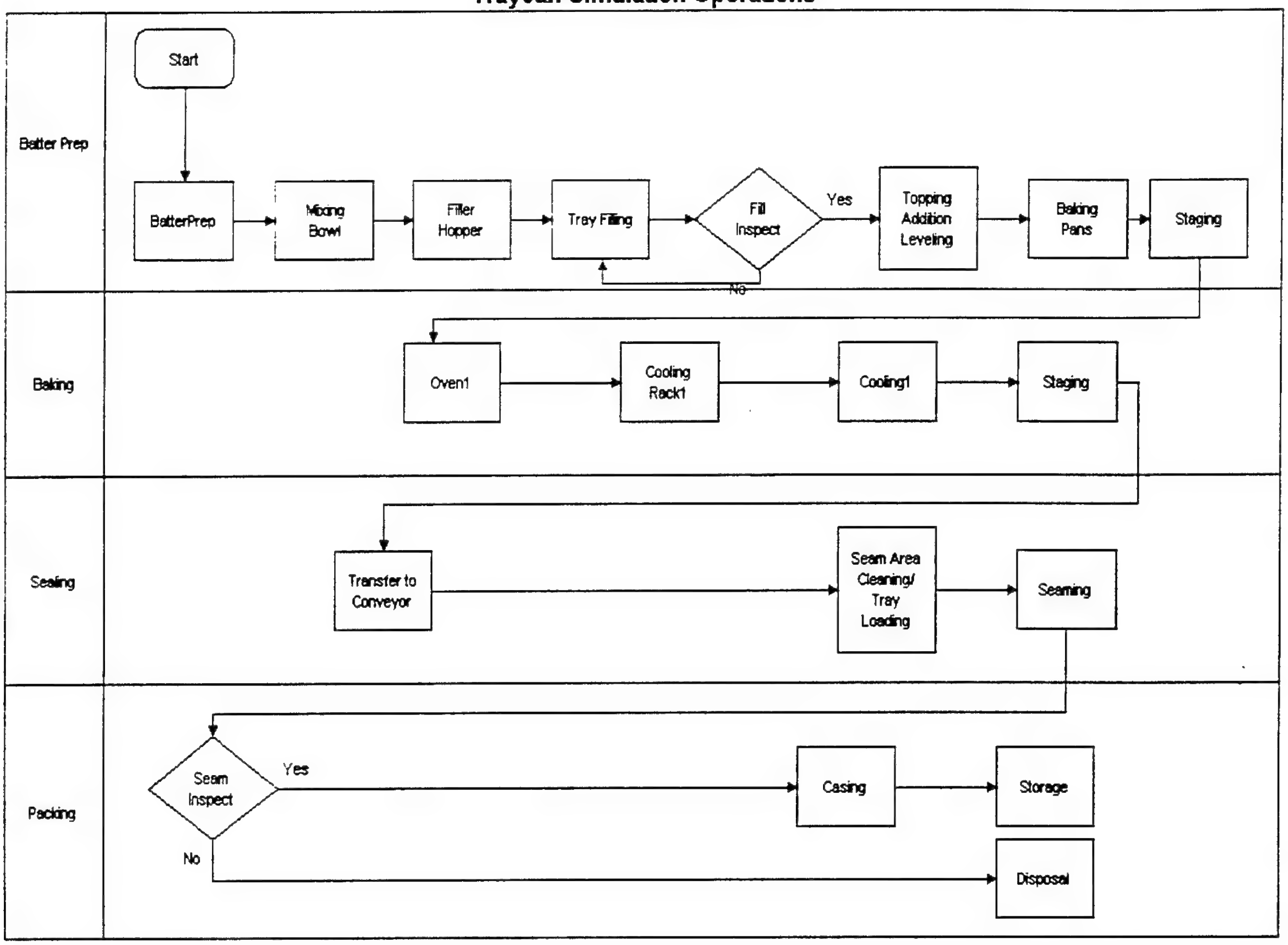
Final unit costs for the tray can simulations had to be calculated manually because the programs divided the total costs by the number of cans processed. The total included unsalvageable rejects. Using the final accepted count yielded higher unit cost based on the expected, unsalvageable reject rate.

The small batch cases included the use of the four available ovens and the equipment currently at the FMT Facility. The commercial scale simulations assumed unit operation capacity would scale by a factor of 5 for capital doubling. Estimated costs of capital equipment are based on the applicable production capacity and a 5-year amortization schedule.

Metal Can Processes

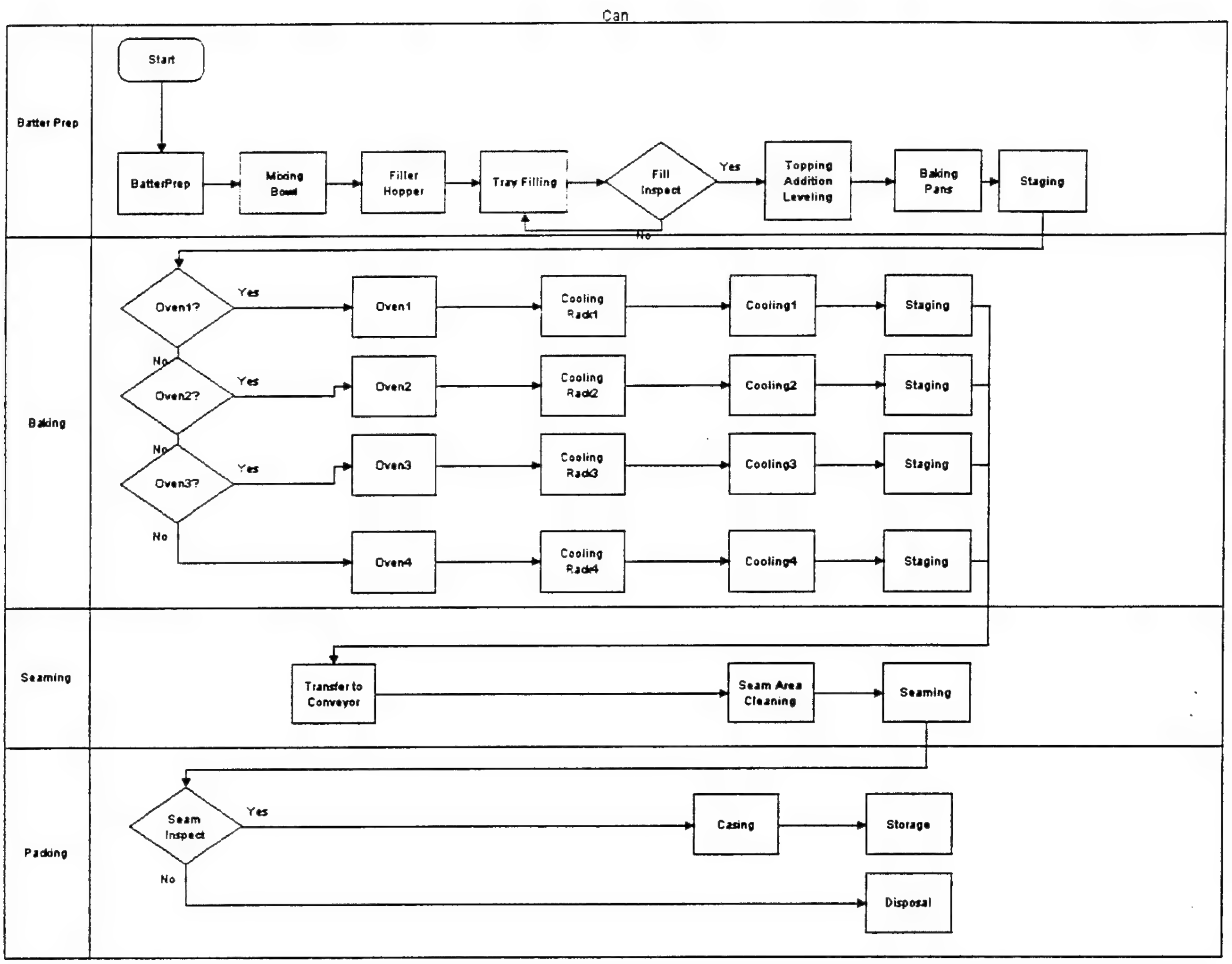
Commercial Scale

Traycan Simulation Operations



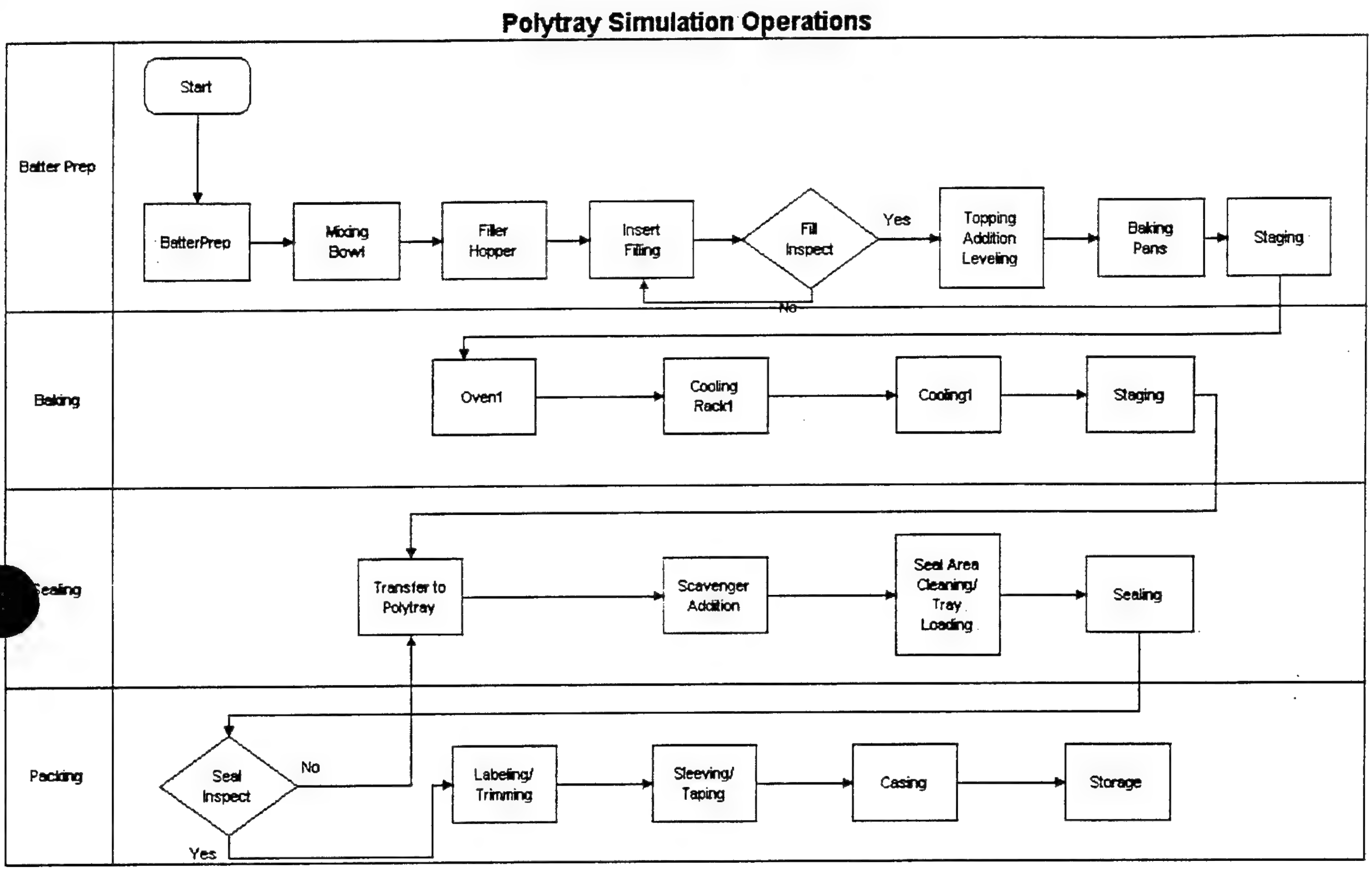
Metal Can Processes

Small Batch



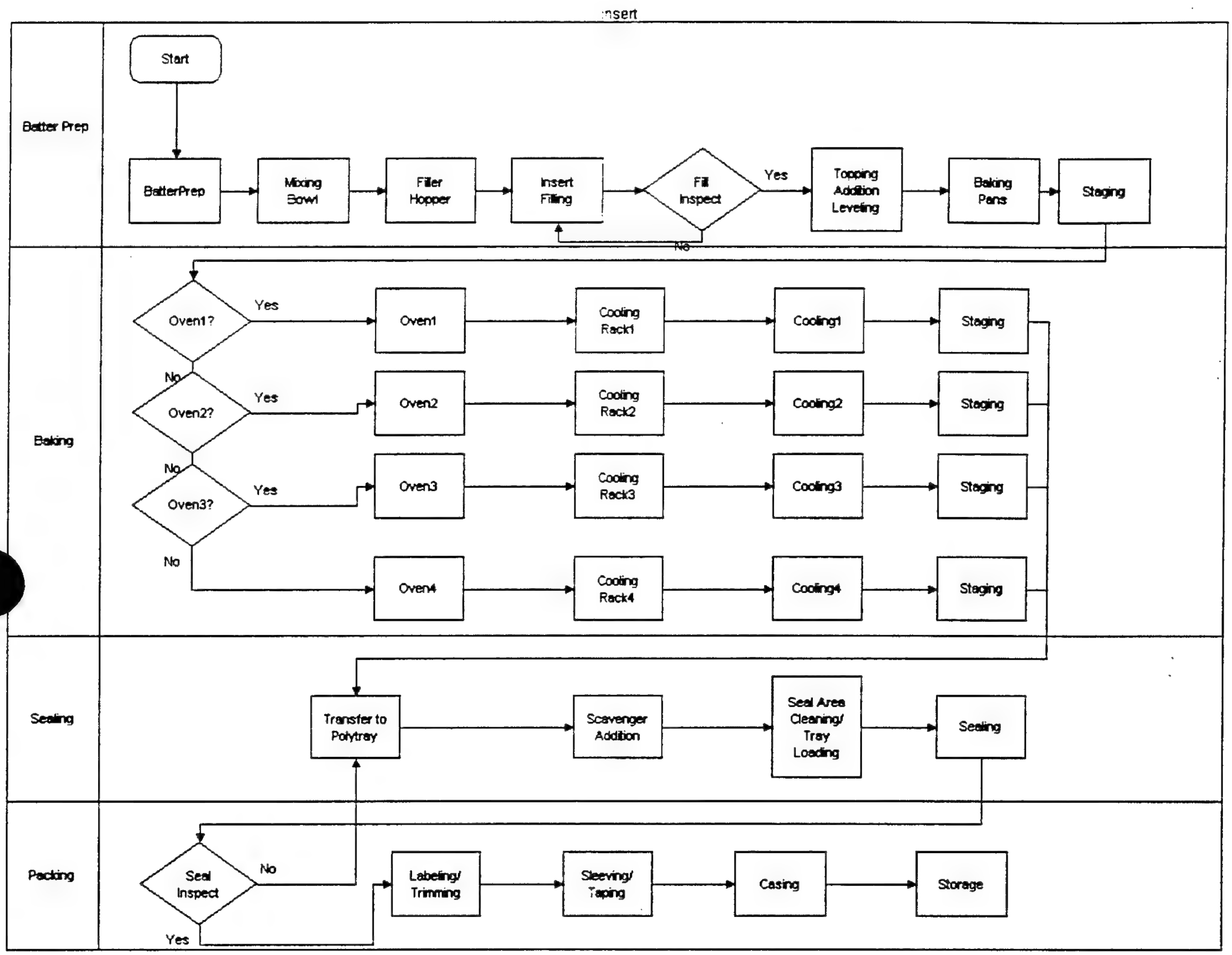
Polytray Processes

Commercial Scale



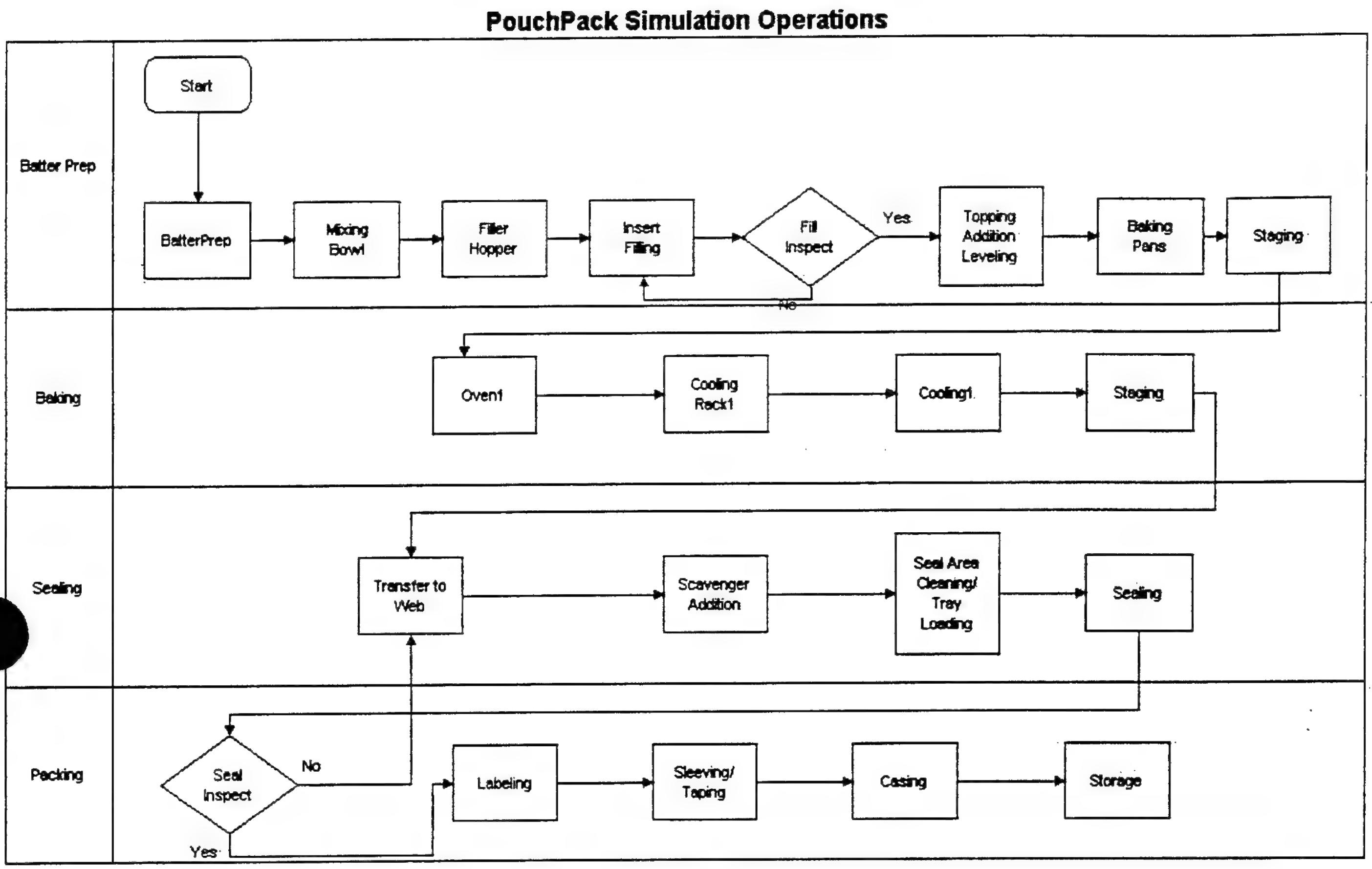
Polytray Processes

Small Batch



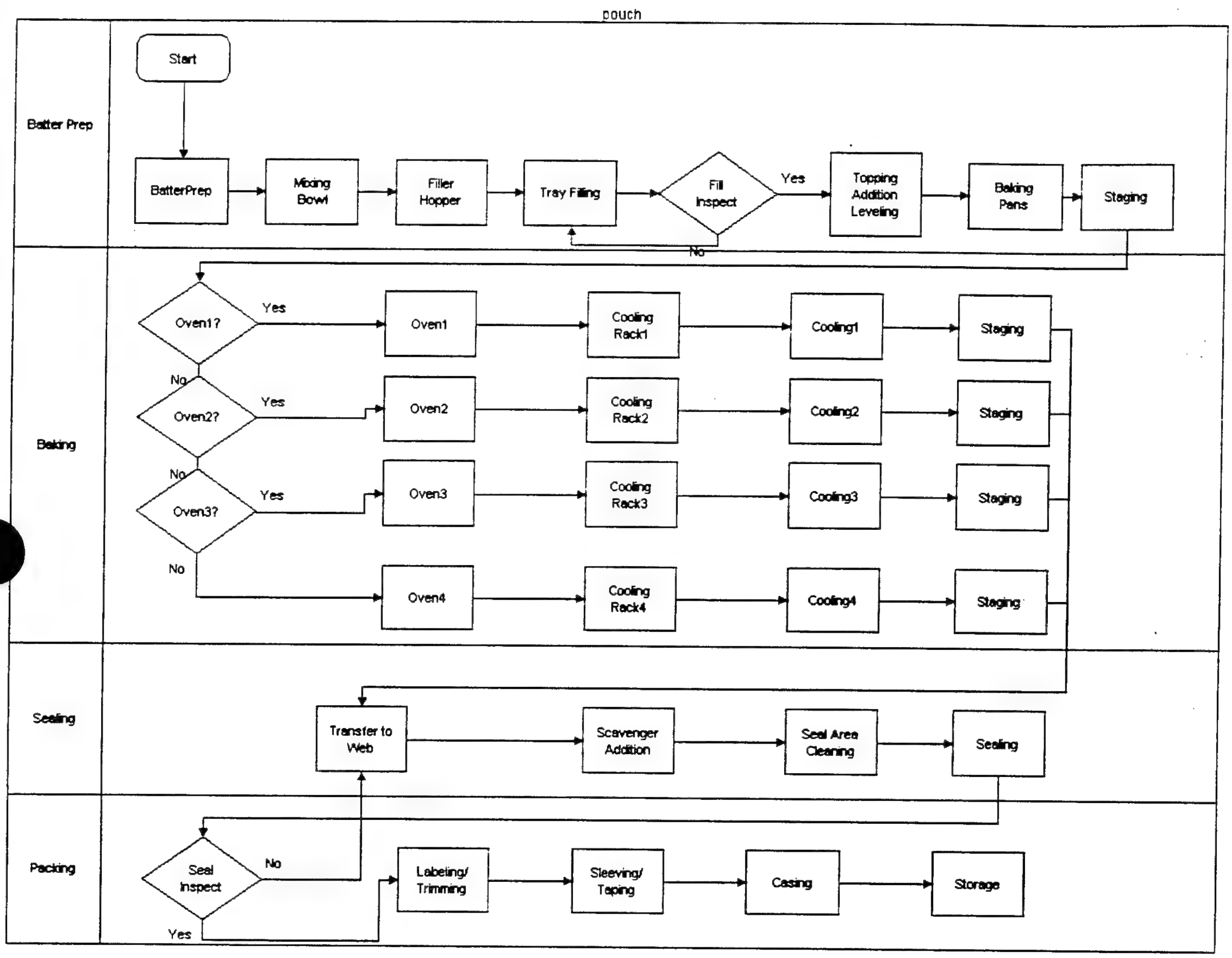
Pouch Pack Processes

Commercial Scale



Polytray Processes

Small Batch



Polytray with Insert Commercial Scale

Resource Statistics - Minutes

	Count	Avg Busy	Avg Idle
Worker	9	25.90	8.10
Ovens	4	8.35	25.65
Mixer	4	8.35	25.65
Cooling	1	33.40	0.60
Sealer	1	33.30	0.70
Cases	500	0.06	33.94
Batter	500	0.07	33.93
Insert	525	0.06	33.94
Polytray	525	0.03	33.97
Scavenger	525	0.07	33.93
Lidstock	525	0.06	33.94
Labels	500	0.05	33.95
Filler	4	4.64	29.36
Baker	1	33.40	0.60
SealerOperator	2	21.90	12.10
Inspector	3	11.08	22.92

Resource Utilization %

Worker	76.17
Ovens	24.56
Mixer	24.56
Cooling	98.24
Sealer	97.94
Cases	0.18
Batter	0.20
Insert	0.19
Polytray	0.10
Scavenger	0.20
Lidstock	0.19
Labels	0.14
Filler	13.65
Baker	98.24
SealerOperator	64.41
Inspector	32.58

Polytray with Insert Commercial Scale (cont.)

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$38.25	$29.14	$0.00	9	$4.25	$0.00
Ovens	$71.74	$17.62	$0.00	4	$17.94	$0.00
Mixer	$56.98	$13.99	$0.00	4	$14.25	$0.00
Cooling	$0.00	$0.00	$0.00	1	$0.00	$0.00
Sealer	$37.89	$37.11	$0.00	1	$37.89	$0.00
Cases	$588.75	$0.00	$588.75	500	$1.18	$1.18
Batter	$350.70	$0.00	$350.70	500	$0.70	$0.70
Insert	$45.09	$0.00	$45.09	525	$0.09	$0.09
Polytray	$447.10	$0.00	$447.10	525	$0.85	$0.85
Scavenger	$210.40	$0.00	$210.40	525	$0.40	$0.40
Lidstock	$150.00	$0.00	$150.00	525	$0.29	$0.29
Labels	$118.25	$0.00	$118.25	500	$0.24	$0.24
Filler	$4.78	$0.65	$0.00	4	$1.20	$0.00
Baker	$4.25	$4.18	$0.00	1	$4.25	$0.00
SealerOperator	$17.00	$10.95	$0.00	2	$8.50	$0.00
Inspector	$25.50	$8.31	$0.00	3	$8.50	$0.00

Polytray with Insert Small Batch Scale

Resource Statistics - Hours

	Count	Avg Busy	Avg Idle
Worker	5	3.06	4.94
Ovens	4	2.50	5.50
Mixer	1	5.08	2.92
Cooling	4	0.63	7.38
Sealer	1	0.23	7.77
Cases	200	<0.01	7.99
Batter	200	0.03	7.97
Insert	200	<0.01	8.00
Polytray	210	<0.01	8.00
Scavenger	210	<0.01	8.00
Lidstock	210	<0.01	8.00
Labels	200	<0.01	8.00
Filler	1	0.93	7.07
Baker	1	1.39	6.61
SealerOperator	1	1.11	6.89
Inspector	1	1.76	6.24

Resource Utilization %

Worker	38.30
Ovens	31.25
Mixer	63.51
Cooling	7.81
Sealer	2.93
Cases	0.07
Batter	0.32
Insert	0.03
Polytray	0.03
Scavenger	0.01
Lidstock	0.01
Labels	0.02
Filler	11.61
Baker	17.36
SealerOperator	13.92
Inspector	21.98

Polytray with Insert Small Batch Scale (cont.)

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$300.00	$114.91	$0.00	5	$60.00	$0.00
Ovens	$253.12	$79.10	$0.00	4	$63.28	$0.00
Mixer	$201.12	$127.73	$0.00	1	$201.12	$0.00
Cooling	$0.00	$0.00	$0.00	4	$0.00	$0.00
Sealer	$534.96	$15.68	$0.00	1	$534.96	$0.00
Cases	$250.00	$0.00	$250.00	200	$1.25	$1.25
Batter	$140.70	$0.00	$140.70	200	$0.70	$0.70
Insert	$18.00	$0.00	$18.00	200	$0.09	$0.09
Polytray	$179.35	$0.00	$179.35	210	$0.85	$0.85
Scavenger	$84.40	$0.00	$84.40	210	$0.40	$0.40
Lidstock	$63.30	$0.00	$63.30	210	$0.30	$0.30
Labels	$50.00	$0.00	$50.00	200	$0.25	$0.25
Filler	$16.88	$1.96	$0.00	1	$16.88	$0.00
Baker	$60.00	$10.42	$0.00	1	$60.00	$0.00
SealerOperator	$120.00	$16.70	$0.00	1	$120.00	$0.00
Inspector	$120.00	$26.38	$0.00	1	$120.00	$0.00

Pouch Pack Commercial Scale

Resource Statistics - Minutes

	Count	Avg Busy	Avg Idle
Worker	9	25.90	8.10
Ovens	4	8.35	25.65
Mixer	4	8.35	25.65
Cooling	1	33.40	0.60
Cases	500	0.06	33.94
Batter	500	0.07	33.93
Scavenger	525	0.07	33.93
Labels	500	0.05	33.95
Filler	4	4.64	29.36
Baker	1	33.40	0.60
SealerOperator	2	21.90	12.10
Inspector	3	11.08	22.92
Cpettray	500	0.07	33.93
Pouch	500	0.07	33.93
HFFS	1	33.30	0.70

Resource Utilization %

Worker	76.17
Ovens	24.56
Mixer	24.56
Cooling	98.24
Cases	0.18
Batter	0.20
Scavenger	0.20
Labels	0.14
Filler	13.65
Baker	98.24
SealerOperator	64.41
Inspector	32.58
Cpettray	0.20
Pouch	0.20
HFFS	97.94

Pouch Pack Commercial Scale (cont.)

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$38.25	$29.14	$0.00	9	$4.25	$0.00
Ovens	$71.74	$17.62	$0.00	4	$17.94	$0.00
Mixer	$56.98	$13.99	$0.00	4	$14.25	$0.00
Cooling	$0.00	$0.00	$0.00	1	$0.00	$0.00
Cases	$588.75	$0.00	$588.75	500	$1.18	$1.18
Batter	$350.70	$0.00	$350.70	500	$0.70	$0.70
Scavenger	$210.40	$0.00	$210.40	525	$0.40	$0.40
Labels	$118.25	$0.00	$118.25	500	$0.24	$0.24
Filler	$4.78	$0.65	$0.00	4	$1.20	$0.00
Baker	$4.25	$4.18	$0.00	1	$4.25	$0.00
SealerOperator	$17.00	$10.95	$0.00	2	$8.50	$0.00
Inspector	$25.50	$8.31	$0.00	3	$8.50	$0.00
Cpettray	$300.60	$0.00	$300.60	500	$0.60	$0.60
Pouch	$400.00	$0.00	$400.00	500	$0.80	$0.80
HFFS	$38.08	$37.30	$0.00	1	$38.08	$0.00

Pouch Pack Small Batch Scale

Resource Statistics - Hours

	Count	Avg Busy	Avg Idle
Worker	5	3.31	4.69
Ovens	4	2.50	5.50
Mixer	1	5.08	2.92
Cooling	4	0.63	7.38
Cases	200	<0.01	7.99
Batter	200	0.03	7.97
Scavenger	210	<0.01	8.00
Labels	200	<0.01	8.00
Filler	1	0.93	7.07
Baker	1	1.39	6.61
SealerOperator	1	0.76	7.24
Inspector	1	1.76	6.24
HFFS	1	0.23	7.77
Pouch	1	0.23	7.77
Cpettray	200	<0.01	8.00

Resource Utilization %

Worker	41.32
Ovens	31.25
Mixer	63.51
Cooling	7.81
Cases	0.07
Batter	0.32
Scavenger	0.01
Labels	0.02
Filler	11.61
Baker	17.36
SealerOperator	9.52
Inspector	21.98
HFFS	2.93
Pouch	2.93
Cpettray	0.03

Pouch Pack Small Batch Scale (cont.)

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$300.00	$123.97	$0.00	5	$60.00	$0.00
Ovens	$253.12	$79.10	$0.00	4	$63.28	$0.00
Mixer	$201.12	$127.73	$0.00	1	$201.12	$0.00
Cooling	$0.00	$0.00	$0.00	4	$0.00	$0.00
Cases	$250.00	$0.00	$250.00	200	$1.25	$1.25
Batter	$140.70	$0.00	$140.70	200	$0.70	$0.70
Scavenger	$84.40	$0.00	$84.40	210	$0.40	$0.40
Labels	$50.00	$0.00	$50.00	200	$0.25	$0.25
Filler	$16.88	$1.96	$0.00	1	$16.88	$0.00
Baker	$60.00	$10.42	$0.00	1	$60.00	$0.00
SealerOperator	$120.00	$11.43	$0.00	1	$120.00	$0.00
Inspector	$120.00	$26.38	$0.00	1	$120.00	$0.00
HFFS	$537.60	$15.75	$0.00	1	$537.60	$0.00
Pouch	$168.80	$0.00	$168.80	1	$168.80	$168.80
Cpettrav	$120.00	$0.00	$120.00	200	$0.60	$0.60

Tray Can Commercial Scale

Resource Statistics - Minutes

	Count	Avg Busy	Avg Idle
Worker	10	19.64	60.26
Ovens	4	8.35	76.65
Mixer	4	8.35	76.65
Cooling	1	33.40	51.60
Cases	500	0.07	84.93
Batter	500	0.07	84.93
Filler	4	4.64	80.36
Baker	1	33.40	51.60
Inspector	3	11.13	73.87
Yaguchi	1	83.50	1.50
Can	500	0.07	84.93
SeamerOperator	1	25.05	8.95

Resource Utilization %

Worker	24.58
Ovens	9.82
Mixer	9.82
Cooling	39.29
Cases	0.08
Batter	0.08
Filler	5.46
Baker	39.29
Inspector	13.10
Yaguchi	98.24
Can	0.08
SeamerOperator	73.68

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$95.63	$22.46	$0.00	10	$9.56	$0.00
Ovens	$179.35	$17.62	$0.00	4	$44.84	$0.00
Mixer	$142.46	$13.99	$0.00	4	$35.61	$0.00
Cooling	$0.00	$0.00	$0.00	1	$0.00	$0.00
Cases	$620.00	$0.00	$620.00	500	$1.24	$1.24
Batter	$350.70	$0.00	$350.70	500	$0.70	$0.70
Filler	$11.96	$0.65	$0.00	4	$2.99	$0.00
Baker	$10.63	$4.18	$0.00	1	$10.63	$0.00
Inspector	$63.75	$8.35	$0.00	3	$21.25	$0.00
Yaguchi	$67.38	$66.19	$0.00	1	$67.38	$0.00
Can	$976.95	$0.00	$976.95	500	$1.95	$1.95
SeamerOperator	$8.50	$6.26	$0.00	1	$8.50	$0.00

Tray Can Small Batch Scale

Resource Statistics - Hours

	Count	Avg Busy	Avg Idle
Worker	5	3.14	4.86
Ovens	4	2.50	5.50
Mixer	1	5.08	2.92
Cooling	4	0.63	7.38
Cases	200	<0.01	7.99
Batter	200	0.03	7.97
Filler	1	0.93	7.07
Baker	1	1.39	6.61
SealerOperator	1	0.28	7.72
Inspector	1	1.67	6.33
Can	200	<0.01	8.00
Yaguchi	1	0.56	7.44
SeamerOperator	1	0.78	7.22

Resource Utilization %

Worker	39.21
Ovens	31.25
Mixer	63.51
Cooling	7.81
Cases	0.07
Batter	0.32
Filler	11.61
Baker	17.36
SealerOperator	3.47
Inspector	20.83
Can	0.03
Yaguchi	6.94
SeamerOperator	9.72

Resource Statistics

	Tot Cost	Tot Busy Cost	Tot Use Cost	Count	Avg Cost	Avg Use Cost
Worker	$300.00	$117.64	$0.00	5	$60.00	$0.00
Ovens	$253.12	$79.10	$0.00	4	$63.28	$0.00
Mixer	$201.12	$127.73	$0.00	1	$201.12	$0.00
Cooling	$0.00	$0.00	$0.00	4	$0.00	$0.00
Cases	$247.50	$0.00	$247.50	200	$1.24	$1.24
Batter	$140.70	$0.00	$140.70	200	$0.70	$0.70
Filler	$16.88	$1.96	$0.00	1	$16.88	$0.00
Baker	$60.00	$10.42	$0.00	1	$60.00	$0.00
SealerOperator	$120.00	$4.17	$0.00	1	$120.00	$0.00
Inspector	$120.00	$25.00	$0.00	1	$120.00	$0.00
Can	$390.00	$0.00	$390.00	200	$1.95	$1.95
Yaguchi	$380.48	$26.42	$0.00	1	$380.48	$0.00
SeamerOperator	$120.00	$11.67	$0.00	1	$120.00	$0.00

Common Resources and Unit Costs

Baker (Labor)

Count : 1
Schedule : Always
Hourly Rate : $7.50
Hourly O/T Rate : $7.50

Batter (Other)

Count : 200
Schedule : Always
Cost Per Use : $0.70

Can (Other)

Count : 200
Schedule : Always
Cost Per Use : $1.95

CanCase (Other)

Count : 1
Schedule : Default
Cost Per Use : $0.60

Cases (Other)

Count : 200
Schedule : Always
Cost Per Use : $1.25

Cooling (Equipment)

Count : 4
Schedule : Always

Cpettray (Other)

Count : 200
Schedule : Always
Cost Per Use : $0.60

Filler (Equipment)

Count : 1
Schedule : Always
Hourly Rate : $2.11
Hourly O/T Rate : $2.11

HFFS (Equipment)

Count : 1
Schedule : Always
Hourly Rate : $67.20
Hourly O/T Rate : $67.20

Insert (Other)

Count : 200
Schedule : Always
Cost Per Use : $0.09

Inspector (Labor)

Count : 1
Schedule : Always
Hourly Rate : $15.00
Hourly O/T Rate : $15.00

Labels (Other)

Count : 200
Schedule : Always
Cost Per Use : $0.25

Lidstock (Other)

Count : 210
Schedule : Always
Cost Per Use : $0.30

Mixer (Equipment)

Count : 1
Schedule : Always
Hourly Rate : $25.14
Hourly O/T Rate : $25.14

Ovens (Equipment)

Count : 4
Schedule : Always
Hourly Rate : $7.91
Hourly O/T Rate : $7.91

Polytray (Other)

Count : 210
Schedule : Always
Cost Per Use : $0.85

Pouch (Other)

Count : 1
Schedule : Always
Cost Per Use : $0.80

Scavenger (Other)

Count : 200
Schedule : Always
Cost Per Use : $0.40

Sealer (Equipment)

Count : 1
Schedule : Always
Hourly Rate : $66.87
Hourly O/T Rate : $66.87

SealerOperator (Labor)

Count : 1
Schedule : Always
Hourly Rate : $15.00
Hourly O/T Rate : $15.00

SeamerOperator (Labor)

Count : 1
Schedule : Always
Hourly Rate : $15.00
Hourly O/T Rate : $15.00

Worker (Labor)

Batter Prep	Count : 4 Schedule : Always Hourly Rate : $7.50 Hourly O/T Rate : $7.50
Packing	Count : 1 Schedule : Always Hourly Rate : $7.50 Hourly O/T Rate : $7.50

Yaguchi (Other)

Count : 1
Schedule : Default
Hourly Rate : $47.56
Hourly O/T Rate : $47.56

COMBAT RATION NETWORK FOR TECHNOLOGY IMPLEMENTATION

(CORANET)

Summary Annual Benefits
200,000 units/yr

	Metal Can	Polytray w/Insert	PouchPack
Traditional Benefit	$0	$ 12,000	$ -28,000
NCIC Benefit	$0	$187,500	$110,100
Total	$0	$199,500	$82,100

Non-traditional Capital Investment Criteria, (NCIC)

Evaluating Costs and Benefits

In this section we describe the results of a cost/benefit analysis that was conducted based on a modification of the NCIC financial evaluation process. NCIC was developed to evaluate difficult-to-estimate costs and benefits of a capital investment project. It does this by asking knowledgeable decision-makers to compare important, but difficult-to-estimate in dollar value, investment criteria with one another using a number to represent their relative merits. By introducing a comparison of relative importance of each criterion to a cost, such as the cost of the investment, the implied dollar value of the difficult-to-quantify criteria can be estimated.

The current decision problem is not a traditional capital investment decision. It was felt that some modification of the process was needed to address this situation. The modification consisted of applying a well-known decision process called the Analytic Hierarchy Process with some features of NCIC. We will describe this process while showing the results in this section.

5.1 Defining Important Criteria

On June 21,1999, a meeting was held at 120 New England Avenue. The purpose was to introduce Mitch Hartson to the NCIC process and to identify important criteria that should be considered in the analysis. Other attendees were John Coburn, Neal Litman, and Tom Boucher. Based on that meeting, six difficult-to-quantify *mission critical* criteria for package selection were identified. They were:

1) Ability to meet surge demands in the short run (**Demand response**).
2) Maximum length of storage time during which the item will be considered fit for human consumption (**Shelf life**).
3) Ease with which cooks can prepare meals and serve. Ability to open the container. Ability to dispose of the container. Management of temporary surplus. Compatibility with existing field equipment (**Ease of field use**).
4) Ability of container to handle shock from aerial delivery. Shock of rough handling in various climates. Survival of container in stacked configurations (**Rough handling**).
5) Ease of assembling item into UGR package. Ease of in plant storage and handling at assembly facility (**Assembly operations performance**).
6) The degree of package standardization with respect to size and shape. Congruence with other menu items which are included in the menu. Impact on assembly operations and field operations (**Package Uniformity**).

5.2 Data Collection

At the June meeting, the results of a simulation study of the additional cost of production for polypropylene tray and PET trays versus the current production costs of metal containers were presented. Initially, these cost estimates were provided based on an annual production of 2 million containers.

At the meeting, the most mission critical difficult-to-quantify criterion was identified to be **Demand response**. It was felt that polypropylene and PET containers were better choices on this criterion. At the June meeting Mitch Hartson was asked to give his best judgement of whether the additional production cost of the polypropylene and PET trays were more important in the decision to adopt them than their better performance on demand response, or vise versa. He was able to render a best judgement on the relative magnitude of importance in this comparison.

Following the meeting, Mitch Hartson was sent a questionnaire in which he was asked to compare the six mission critical criteria with each other and render a judgement of relative importance. He was also asked to compare the three alternative containers on the basis of each criterion. This information, along with that of the June meeting, was used as input for the cost/benefit comparison. This shall be explained in the next section.

5.2 Data Analysis on Mission Critical Criteria

The result of the comparisons of mission critical criteria is shown in Table 1, below. The first row lists the six mission critical alternatives that were identified in section 5.1. The second row, criteria ranking, shows the importance of each criteria based on a relative scale that adds to 1.0. Thus, in comparing demand response to shelf life, demand response was considered to be $\frac{0.286}{0.191} = 1.5$ times more important in the decision. The last three rows and first six columns of the table show the comparison of each container alternative on each criterion. In the column for demand response, polypropylene is considered to be the best alternative. It is $\frac{0.5}{0.125} = 4$ times better than the metal container on this criterion. The other entries in the table have similar meaning.

CRITERIA WEIGHTS

	1	2	3	4	5	6	WEIGHTS
1. Demand response	1	1.5	2.0	2.0	2.0	3.0	0.286
2. Shelf life	0.67	1	1.33	1.33	1.33	2.0	0.191
3. Ease of use by cooks in the field	0.5	0.75	1	1	1	1.5	0.143
4. Ability to withstand rough handling	0.5	0.75	1.0	1	1	1.5	0.143
5. Compatibility with assembly operations	0.5	0.75	1	1	1	1.5	0.143
6. Package uniformity	0.33	0.5	0.67	0.67	0.67	1	0.094

The above weights to the right of the table show the relative importance of the criteria. The following is the judgement of the relative score of each alternative on each criterion.

Criteria	Polypropylene	PET	Metal
1. Demand response	0.5	0.375	0.125
2. Shelf life	0.2	0.4	0.4
3. Ease of use in the field	0.533	0.4	0.067
4. Ability to withstand handling	0.167	0.167	0.667
5. Compatibility with assembly	0.5	0.334	0.166
6. Package uniformity	0.18	0.27	0.55

Comparison of containers on mission critical criteria

	1 Demand response	2 Shelf life	3 Ease of field use	4 Rough handling	5 Assembly operations performance	6 Package uniformity	7	8 Alternative ranking
Criteria Ranking =>	0.286	0.191	0.143	0.143	0.143	0.094		
Alternative							ΣCxA	
Poly	0.5	0.2	0.533	0.167	0.5	0.18	0.369	#1
PET	0.375	0.4	0.4	0.167	0.334	0.27	0.338	#2
Metal	0.125	0.4	0.067	0.667	0.166	0.55	0.293	#3

The best overall alternative is determined by multiplying the criteria weight by the weight of the alternative on that criterion and summing the result for each alternative. This is shown in column 7. The result shows an overall preference for the polypropylene tray. The final ranking is shown in column 8.

5.3 Data Analysis on Economic Criteria

In order to compare mission critical criteria to economic criteria on a financial basis, we convert their weights to dollar values. The assumption is that the costs or benefits of the mission critical criteria are ultimately economic costs to the government for the inefficiencies of the container in use. The estimates made of the relative importance of demand response to the increased production cost were used to imply the economic value of demand response. Since estimates were given for both the polypropylene tray and the PET tray, the analysis had a range of possible values with which to work. A best guess, low, and high value were used. There was no significant change in the result. Therefore, in Table 2, below, we show the result for the best guess, or average value.

The first column shows the relative weights of each criterion, taken from Table 1. Based on a comparison of the relative importance of increased production cost to demand response, the dollar value of the first entry in the first row, second column (demand response) was estimated. Using the ratio of weights, the remaining values in the second column were estimated. For example, $\frac{0.191}{0.286} \cdot 6950 = 4641$. Multiplying the second column by the relative weights of the alternatives as taken from Table 1, yields the relative dollar values apportioned to each alternative. For example, $4641 \cdot 0.2 = 928$. Note that the performance totals in dollar values represent the same relative weights as that which is given in Table 1; i.e., 0.369, 0.338, 0.293. However, when the production cost differentials are subtracted, the relative scores of the three containers is quite close, the polypropylene tray being slightly better.

Table 2. Comparison of containers on economic value basis

$$\begin{bmatrix} WEIGHTS \\ 0.286 \\ 0.191 \\ 0.143 \\ 0.143 \\ 0.143 \\ 0.094 \end{bmatrix} \Rightarrow \begin{bmatrix} \$(000) \\ 6950 \\ 4641 \\ 3475 \\ 3475 \\ 3475 \\ 2284 \end{bmatrix} \times \begin{bmatrix} poly & PET & Metal \\ 0.5 & 0.375 & 0.125 \\ 0.2 & 0.4 & 0.4 \\ 0.533 & 0.4 & 0.067 \\ 0.167 & 0.167 & 0.667 \\ 0.5 & 0.334 & 0.166 \\ 0.18 & 0.27 & 0.55 \end{bmatrix} \Rightarrow \begin{bmatrix} poly & PET & Metal \\ 3475 & 2606 & 869 \\ 928 & 1856 & 1856 \\ 1852 & 1390 & 233 \\ 580 & 580 & 2318 \\ 1738 & 1161 & 577 \\ 411 & 617 & 1256 \end{bmatrix}$$

$$Performancetotals\ 8{,}984\ 8{,}210\ 7{,}109$$

$$Less\,Cost\,differential\quad overbase\,120,-280,0$$

$$Performanceand\cos t\quad 9{,}104\ 7{,}930\ 7{,}109$$

$$Indexnumberrank\ 0.38\ \ 0.33\ \ 0.29$$

Logic for computing the relationship between performance criteria and cost:

During the June 21, 1999 session, it was determined that the most important mission critical performance criteria was "Demand Response". From the initial simulations of production requirements, the annual cost for producing the polypropylene tray would have been about $1,480,000 higher than the metal can. The PET tray would cost $1,140,000 more than the metal can.

After review of the costs, Mitch Hartson was asked how much more important the relative improvement in demand response of the poly (PRT) tray vs. the metal can was in comparison to their increased cost. He suggested the following ratios:

Poly: 1.5 (50% more important)

PET: 1.75 (75% more important)

Since we already had an estimate of the cost increases, we could compute the implied dollar value of the demand response from the preliminary cost information as follows:

	Increased cost		Implied demand response
Polypropylene	$1,480,000	X 1.5	$2,220,000
PET	$1,140,000	X 1.75	$1,995,000

The next step of the analysis involved correlating the relative weights of the three containers on the criteria of "Demand Response", based on feedback from Mitch Hartson on a second questionnaire. Since the analysis later was shifted to account for an annual production of only 200,000 , the implied value was reduced accordingly.

Container	Computed Weights
Poly	0.5
PET	0.75
Metal Tray	0.125

This implies the following value for the value of "Demand Response":

0.5-0.125=0.375-----------------$2,220,000/0.375 = $5,920,000

or

0.375-0.125=0.25----------------$1,995,000/0.25=$7,980,000

Averaging these cost yields an estimated value of $6,950,000.

Using this figure a base, all other criteria can be valued accordingly.

Read and Write

SCIENTIFIC AND TECHNICAL INFORMATION SYSTEM

1. Acc. Number	1A. Act. Code	2. Trans Type	3. Effort Status	4. Perf. Meth.
DS000443	**AQPO**	**M Modify A Record**	**C Completed**	**C Contract**

Performance Type 5.	6. Date of Summary	7. Prec. Sum Date	8. Start Date	9. End Date	Continuous End
R RDT&E Work Unit	2000/09/26	1997/12/29	1996/1/06	1999/08/31	☑

10. Sec. Class.	18. Distribution Code	19. Distribution Reason
U Unclassified	**A Distribution Unlimited**	**PB Public Release**

20. Title
TECHNOLOGY APPLICATION AND ASSESSMENT - STP 1002

22. Linking Accession Number (Select Up to Two)	23. Local Control Number	24. Search Data
DS 00441	96004	

25. Subject Categories

Code	Description
0608	**Food, Food Service and Nutrition**
1308	**Manufacturing and Industrial Engineering and Control of Production Systems**

26.1 Mission Area

Code	Description
5.1	**Logistics**

26.2 Function Code

Code	Description
7.2	**Manufacturing Technology**

26.3 Technology Code

Code	Description
4.4.2	**4.4.2 Computer-Aided Manufacturing, Inspection and Testing Technology**

27. Resp. Org. Source
432549

27.1 Responsible Organization Name
DEFENSE LOGISTICS AGENCY FORT BELVOIR VA

27.2 Responsible Organization Component Name
J339, TECHNICAL ENTERPRISE DIVISION

27.4 Responsible Individual

Last Name	First Name	MI
EGGERS	RUSSELL	K

27.5 Resp. Indiv. Off. Sys.	27.6 Resp. Indiv. Phone	27.7 Resp. Indiv. DSN No.
J339	703-767-1417	427-1417

28. Perf. Org. Source	28.1 Performing Organization Name
410970	RUTGERS - THE STATE UNIV PISCATAWAY NJ

28.2 Performing Organization Component Name

CENTER FOR ADVANCED FOOD TECHNOLOGY

28.4 Performing Individual

Last Name	First Name	MI
COBURN	JOHN	F

28.5 Perf. Indiv. Off. Sys.	28.6 Perf. Indiv. Phone	28.7 Perf. Indiv. DSN No.
CORANET	732-445-6130	

28.8 Associate Investigator Names (Last, First, MI) JEFFREY. S, CANAVAN

35. Keyword Text

RATIONS
THERMOSTABILIZED
PROCESS
QUALITY
CONTROL
CIM ARCHITECTURE
MACHINE VISION
ROBOTICS
DUAL USE
FLEXIBILITY
INTEGRATION
DATA BASE
SHOP FLOOR
IMPLEMENTATION
TECHNOLOGY TRANSFER

36.1 Objective
TO PROVIDE SKILLED ASSISTANCE TO PRODUCERS OF RATIONS TO HELP THEM DETERMINE THE USEFULLNESS OF NEW OR DIFFERENT TECHNOLOGY, OR TO HELP THEM IMPLEMENT ADVANCED TECHNOLOGY IN THEIR OWN PLANTS. THE PRIMARY TASK OF THIS PROJECT IS TO STUDY THE MANUFACTURABILITY OF ENTREES IN POLYMERIC TRAYS FOR GROUP FEEDING.

37.1 Approach
THIS PROJECT IS ESTABLISHED TO PROVIDE ASSISTANCE ALMOST ON DEMAND FROM RATION PRODUCERS. IN THIS TIME PERIOD, A STUDY ON MANUFACTURABILITY OF ENTREES IN POLYMERIC TRAY PACK CONTAINERS WILL BE CONDUCTED, AND THE RESULTS WILL BE SHARED WITH ALL OF INDUSTRY.

38.1 Progress
THIS PROJECT HAS BEEN COMPLETED, AND THE FINAL REORT IS BEING SUBMITTED

30. Primary PE No.
0708011S

31. 1st Contrib. PE No.

32. 2nd Contrib PE No.

30A. Primary Proj. No.
96004

31A. 1st Contrib. Proj. No.

32A. 2nd Contrib. Proj. No.

30B. Primary Task No.
STP 1002

31B. 1st Contrib. Task No.

32B. 2nd Contrib. Task No.

30. Primary Funding Data			31. 1st Cont. Funding Data			32. 2nd Cont. Funding Data			33. Contract Rollup Indicator
Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	
C1	C2	C3	C1	C2	C3	C1	C2	C3	C
1999	6285	1							
D1	D2	D3	D1	D2	D3	D1	D2	D3	D
1998	5490	1							
E1	E2	E3	E1	E2	E3	E1	E2	E3	E
1997	11247	1							
F1	F2	F3	F1	F2	F3	F1	F2	F3	F
1996	16736	1							
G1	G2	G3	G1	G2	G3	G1	G2	G3	G

39A. Product Set No.	39.1A Prod. Title Class Code	39.2A Product Title
	Unclassified	

39.3A Product ID/Report No	39.4A Product AD No	39.5A Product Indicator

39B. Product Set No.	39.1B Prod. Title Class Code	39.2B Product Title
	Unclassified	

39.3B Product ID/Report No	39.4B Product AD No	39.5B Product Indicator

39C. Product Set No.	39.1C Prod. Title Class Code	39.2C Product Title
	Unclassified	

39.3C Product ID/Report No	39.4C Product AD No	39.5C Product Indicator

39D. Product Set No.	39.1D Prod. Title Class Code	39.2D Product Title
	Unclassified	

39.3D Product ID/Report No	39.4D Product AD No	39.5D Product Indicator

39E. Product Set No.	39.1E Prod. Title Class Code	39.2E Product Title
	Unclassified	

39.3E Product ID/Report No	39.4E Product AD No	39.5E Product Indicator

34. Contract/Grant/Trans. No.	34.1 Contract Effective Date	
34.2 Contract Expiration Date	**34.3 Contract Face Value**	**34.4 Contract Cum. to Date**
SPO10396D0016/05	1996/11/06	
1999/08/31	397577	376310

40. Dom. Tech Trans.	
41. Study Category	
42. Spec. Study Sub	
44. Prim. Proj. Serial No	
45. Int. Sources Con.	
46. Processing Date	
47. Receipt Date	

49. Thrust Indicator

Technology for Affordability

Focal Point
Russell Eggers

Author
Mark Glover

Status Code